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Volume 19, Number 8, April 30, 1965

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstract 13611.

12892 (AD-423696) MEDICAL CARE IN SHELTERS. A REFERENCE MANUAL FOR ALLIED HEALTH WORKERS AND SELECTED, TRAINED LAYMEN. (Public Health Service, Washington, D. C.). Dec. 1963. Contract OCD-OS-62-100. 140p. $3.00(OTS).

This manual is intended as a quick reference guide for allied health workers and selected, trained laymen charged with the responsibility of administering shelter medical care in the absence of a physician. Its purpose is to aid them to quickly determine the treatment, under the austere limitations of the shelter, based on common symptoms. Recommended treatment is primarily for symptoms rather than the uncertainties of inexperienced diagnosis. (auth)

12893 (HW-83613) PROGRESS IN BIOLOGICAL RESEARCH. A Summary of Hanford Laboratories Achievements in These Programs under General Electric, 1956–1964. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1964. Contract AT-(45-1)-1350. 43p. Dep.; $2.00(OTS).

The scope of research studies in the field of biology from 1956 to 1964 is reviewed. Emphasis was placed on studies in small animals of the metabolism and toxicity of a number of radionuclides, including ^{238}Pu, ^{239}Pu, ^{237}Np, ^{45}Ca, ^{90}Sr, ^{3}H, ^{106}Ru, ^{65}Zn, ^{32}P, ^{137}Cs, ^{144}Ce, and ^{144}Pr; the use of sheep, swine, and cattle in studies of the metabolism and toxicity of ^{131}I, ^{90}Sr, ^{65}Zn, and ^{137}Cs, and the transfer of various radionuclides from plasma to milk; skin irradiation of livestock by α or β particles; the metabolism and pathological effects in animals of inhaled radionuclides using aerosols containing $^{239}PuO_2$, $^{90}SrSO_4$, $Ag^{131}I$, $^{106}RuO_2$, and ^{144}Ce; the effects of various treatments on the removal of radioactive materials deposited in the body; radiation effects on metabolism in microorganisms; graft-host response in radiation chimeras; the effects of fission products released in reactor effluent on aquatic organisms in the Columbia River; and ecological studies of the environs of the Hanford area. The development of a strain of miniature swine for use as a stand-in for man in studies of radionuclide metabolism and toxicology is reported. Educational and training activities are reviewed. No technical data are included. (C.H.)

12894 (JPRS-28356) CLINICAL AND EXPERIMENTAL ENDOCRINOLOGY. Translated from Probl. Endokrinol. i Gormonoterap., 10: No. 5, 41-8; 70-4(Sept.-Oct. 1964). 22p. (TT-65-30152). $1.00(OTS).

An abstract was prepared on one section of this translation. The other section discusses the treatment of mental disturbances. (C.H.)

For an abstract of the individual paper see: 13093.

12895 IMMUNOLOGICAL PROPERTIES OF CHEMICALLY INDUCED SARCOMAS. M. Feldman, A. Globerson, and D. Yaffe (Weizmann Inst. of Science, Rehovoth, Israel). Acta Unio Intern. Contra Cancrum, 19: 65-72 (1963).

Subcutaneous sarcomas were produced by 3,4-benzpyrene (1.5%, injected subcutaneously, 0.2 ml in sesame oil or tricaprilin) in mice of the C57B1 and C3H strains. Sarcomas produced in the C57B1 mice were tested for their possible antigenicity by isoimmunization. Such isografts of benzpyrene tumors elicited a specific immune response. Cross-grafting experiments indicated that different tumors of animals of the same strain differ in their antigenicity. Radioinduced chimeras were used to study host factors controlling the formation of tumor metastasis. Tumors that normally do not produce metastasis formed lymph node metastasis in certain genetic combinations of radiation chimeras. Thus, sarcoma C10, of C3H mouse origin, developed metastasis only in an isologous system, i.e. when the tumor, the inoculated hemopoietic cells, and the irradiated host, were of the same or isoantigenic constitution. The metastasis is more susceptible than the original graft to the host immune response. On the other hand, sarcoma MC1M metastasized in homologous chimeric hosts produced by fetal C57B1 cells inoculated into C57B1 mice. Homografts of sarcoma SBL1, produced in C57B1 animals, showed progressive growth of the original transplant in the two groups of homologous chimeric hosts, i.e. in irradiated C3H mice protected by C3H spleen cells, and in irradiated C3H mice protected by fetal C3H cells. Yet metastasis developed only in the homologous animals protected by fetal cells, i.e. in immunologically less resistant hosts. It therefore appears that in addition to the effects of whole-body irradiation, which promoted the formation of metastasis in isologous systems, definite immunological conditions, manifested in homologous systems, are among the determining factors in a host-tumor relation which control the development of metastasis. (TCO)

12896 AUTOLOGOUS BONE-MARROW TRANSFUSION FOLLOWING CHEMOTHERAPY. Leo M. Meyer, Theodore D. Fliedner, and Eugene P. Cronkite (South Nassau Communities Hospital, Oceanside, N. Y. and Brookhaven National Lab., Upton, N. Y.). Ann. N. Y. Acad. Sci., 114: 499-508(Mar. 31, 1964).

Patients with a variety of malignant disorders, mainly in lymphoma and pulmonary groups, were treated with 0.2 and 0.3 mg HN_2/kg body weight on each of four consecutive days. Where autologous bone marrow transplantation was contemplated, marrow was removed from posterior iliac crests and/or sternum, in some instances tagged in vivo or in vitro with tritium-labeled thymidine, glycerol added to 15% volume, frozen at 1°C per min to −25°C, rapidly to −50°C, and stored at −80°C in dry ice and alcohol. Marrow was reinfused into some patients 6-12 days after completion of HN_2 infusion. The results showed that following admin-

istration of 0.8 or 1.2 mg HN_2/kg body weight there was no significant difference in the rate of fall or return to normal of leukocytes and platelets, regardless of reinfusion of autologous bone marrow at the time of maximal leukopenia and thrombopenia. It appears that there was probably no protection afforded, leukopenia and thrombopenia developed and recovery from these states occurred at about the same time in treated and untreated patients. (P.C.H.)

12897 THE EFFECT OF METEOROLOGICAL PHENOMENA ON ACUTE MYOCARDIAL INFARCTION IN STAMFORD, CONNECTICUT. D. H. Fogel and Norman Righthand (Stamford Hospital, Conn.). Brit. Heart J., 26: 255-60(Mar. 1964).

In an attempt to elucidate the possible role of meteorological factors in disease, a study was made in which mean temperature, barometric pressure, humidity, sun spots, and cosmic rays were correlated with the number of attacks of acute myocardial infarction in Stamford, Conn., from 1952 to 1958. The meteorological data assembled included monthly values of total precipitation and maximum, minimum, and average temperature and barometric pressure from the reports of the U. S. Weather Bureau. For the sun spot data, monthly, unsmoothed, relative numbers were used as recorded by the American Association of Variable Star Observers. The cosmic ray data were taken as published for Cheltenham, Maryland by the Carnegie Institution, Washington D. C., as well as some recent unpublished values. The effect of these meteorological data on the occurrence of attacks of acute myocardial infarction was observed by computing the coefficient of correlation by the procedure of Correlation By Thirds. From 1952 to 1958 in Stamford, Conn. there were 1663 attacks of acute myocardial infarction. During the spring months (Mar., Apr., May) 450 attacks occurred; 406 occurred both in summer (June, July, Aug.) and in autumn (Sept., Oct., Nov.); and 401 occurred in winter (Dec., Jan., Feb.). The three highest monthly incidences were Apr. (165), May (157), and Jan. (151); the lowest were Aug. (121) and Dec. (124). These differences in seasonal and monthly incidences were not statistically significant. To ascertain effects of meteorological phenomena, the incidence of attacks was divided into three main categories: total attacks, men and women; total attacks, men; and total attacks, women. For comparative purposes a fourth category was included; namely total deaths from all causes. No correlation between the incidence of attacks of acute myocardial infarction in the three listed categories was found with temperature, precipitation, barometric pressure, sun spot activity, and cosmic rays. Temperature fluctuations and sudden wide fluctuations of barometric pressure had no significant coefficient of correlation with the incidence of attacks. However, increased sun spot activity had a medium coefficient of correlation (+0.339) with the total deaths from all causes, except acute myocardial infarction; that is, it had a moderate augmenting effect on the incidence of deaths from all causes, except myocardial infarction. However, with the χ^2 test, there was no statistical significance in the effect of sun spot activity on total deaths from all causes. (BBB)

12898 C.N.E.N.'S SEVEN YEARS OF ACTIVITY IN BIOLOGICAL RESEARCH AND HEALTH PROTECTION–THE CASACCIA LABORATORIES. Carlo Polvani (CNEN, Rome). Comit. Nazl. Energia Nucl., Notiziario, 10: No. 12, 27-43(Dec. 1964). (In Italian)

The Director of CNEN's Division of Biology and Health Protection reviews the Division's activities from December 1956, when the study Group for Research on Radioisotopes was established, through the end of 1964. (editor)

12899 THE NUCLEAR RESEARCH CENTER AND PHOTOGRAPHY. Roberto Colombo (C.C.R.-EURATOM, Ispra, Italy). Ing. Nucl., 5: No. 5, 33-9(Sept.-Oct. 1964). (In Italian)

Photographic methods and their application at the Ispra Nuclear Research Center are described. Examples given are the use of infrared radiation in microscopic photography and photographic and biological investigations of a tissue sample from the foot of the mollusk Viviparus ater. (auth)

12900 THE CURRENT STATUS OF NUCLEAR MEDICINE IN JAPAN. Teruo Nagai. Isotopes Radiation Technol., 2: 170-1(Winter 1964-65).

Developments in nuclear medicine in Japan are reviewed. Radiodiagnosis is discussed and instrumentation listed. (M.C.G.)

12901 A PRELIMINARY STUDY OF THE PROSPECT OF INDUCING IMMUNITY IN FASCIOLIASIS BY MEANS OF INFECTIONS WITH X-IRRADIATED METACERCARIAL CYSTS AND SUBSEQUENT CHALLENGE WITH NORMAL CYSTS OF FASCIOLA HEPATICA L. Ben Dawes (King's Coll., London). Parasitology, 54: 369-89(May 1964).

Metacercarial cysts of the liver fluke x irradiated at 3 kR were given orally to 32 mice; 8 mice received 20 cysts each and 10 mice 40 cysts each. In serial kills 9 to 24 days after infection 127 young flukes were recovered in the liver. The flukes were stunted and inhibited in development. Over a period of 8 to 22 days the length and breadth of the flukes increased from 0.53 × 0.27 mm to 1.12 × 0.37 mm, whereas the mean length and breadth of normal flukes 22 days old is 3.4 × 1.9 mm. The intestines of the flukes have about 10 to 14 lateral diverticula or sacculations but not normal branches during this period. In the liver sections after 12- to 29-day infections, 16 dead flukes were observed in various stages of disintegration but live flukes were noted in all stages from 8 days onwards, although some of them were injured by inflammatory processes set up in the liver. The remaining 14 mice that received 40 x irradiated cysts each were challenged 22 days later with 10 or 5 normal cysts. This was followed by serial kills at intervals during the period 8 to 53 days after infection. Three almost mature flukes were recovered at 32 days and one mature fluke at 39 days. The mature fluke was of unusually small size (6.4 × 4.3 mm), but it had shed eggs into the bile duct. The numbers of flukes of the challenge infections did not differ significantly from those of normal controls: 4.4 flukes per mouse and 55.4 flukes per 100 cysts. In control experiments 10 mice received 10 normal cysts each and in 22- to 29-day infections 34 flukes were recovered in groups of 3-5 per mouse, providing 4.25 flukes per mouse and 42.5 flukes per 100 cysts. There is, therefore, no evidence of immunity in terms of either delayed maturation or reduced flukes burdens. At all stages of infection flukes of the challenge infection resembled flukes of single normal infections, except for an apparent diminution of growth about 3 to 4 weeks after infection. This accords with generally accepted opinion that any small degree of immunity that is acquired by the hosts of liver flukes is almost undemonstrable. (TCO)

12902 GULLIVER: AN INSTRUMENTED RADIOISOTOPIC EXPERIMENT TO DETECT LIFE ON MARS. Gilbert V. Levin (Hazleton Labs., Inc., Falls Church, Va.). 5p. (CONF-641012-1)

From Symposium on Recent Developments in Research Methods and Instrumentation, Bethesda, Md.

The limitations of extraterrestrial life search tactics are discussed. Gulliver is a life detection system based on the fundamental concept of metabolism; it uses radioactive compounds which are incorporated by organisms, resulting in evolution of $^{14}CO_2$. The current model of Gulliver and its testing are discussed. (D.L.C.)

Ecology

Refer also to abstract 13625.

12903 (BNL-7837) THE AUTUMNAL SEED RAIN IN AN IRRADIATED FOREST. Richard H. Wagner (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT (30-2)- Gen-16. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The autumnal seed rain in the irradiated oak-pine forest facility of Brookhaven National Laboratory was sampled using silicone grease coated decimeter squares of light

sheet aluminum. Two peaks during the sampling period August 15 to December 10, 1963, are noted together with the cumulative total of seeds per hectare over the entire collecting period for the more important species: early fall, Erigeron canadensis (915,662); late fall, various Astereae (180,072), Phragmites communis (216,867), and Typha latifolia (84,337). That the traps recorded a predominance of wind dispersed seed was due in part to a paucity of fall ripening fleshy fruits in the area and the previous dispersal by birds of mid-summer ripening species common to the forest such as blackberry and blueberry. (auth)

12904 (HW-SA-3402) CANOPY COVERAGE OF THE DESERT SHRUB VEGETATION MOSAIC OF THE NEVADA TEST SITE. W. H. Rickard and Janice C. Beatley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash. and California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [Mar. 6, 1964]. Contracts AT(29-2)-517 and AT(04-1)-Gen-12. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Canopy-coverage provided by desert shrubs and perennial grasses and forbs was determined on 44 relatively undisturbed plots scattered throughout the vegetation mosaic of the Nevada Test Site. The dominant shrubs were Larrea divaricata, Grayia spinosa, Lycium andersonii, Franseria dumosa, Coleogyne ramosissima, Atriplex confertifolia, Artemisia tridentata, and A. arbuscula susp. nova. An increase in elevation between and within basins generally showed an increase in canopy-coverage provided by the shrubs. Canopy-coverage (percentage of ground cover) ranged from 2.7% in an Atriplex confertifolia stand to 28.4% in an Artemisia arbuscula subsp. nova stand. Perennial grasses and forbs contributed little to canopy-coverage. The grasses most frequently encountered were Oryzopsis hymenoides and Stipa speciosa. Thirty-four of the same plots (except Coleogyne and Artemisia) measured for shrub canopy-coverage were also analyzed for their contribution to canopy-coverage provided by annuals in the spring of 1960. The generally sparse crop of annuals varied greatly from plot to plot as to amount of canopy-cover and also as to species composition. Larrea plots provided the greatest amount of annual canopy-cover. Chaenactis stevioides was most often the dominant annual encountered throughout the vegetation mosaic. Other important annuals were Mentzelia veatchiana, Eriogonum maculatum, Eriophyllum pringlei, Bromus rubens, Cryptantha nevadensis, C. circumscissa, C. pterocarya, and Amsinckia tessellata. (auth)

12905 (ORNL-TM-1008) THE SYSTEMS APPROACH IN RADIATION ECOLOGY. Bernard C. Patten (Oak Ridge National Lab., Tenn.). Nov. 16, 1964. Contract W-7405-eng-26. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The applications of graph theory and compartment theory to radioecological problems which concern the relationships between structure and function in coupled ecosystems is described. These two areas of mathematics are being explored to provide a general conceptual basis for unification of a developing program in Systems Ecology at ORNL. (auth)

12906 (TID-21357) BIOCLIMATIC AND SOILS INVESTIGATIONS IN FOREST ENVIRONMENTS. V. SOLAR RADIATION MEASUREMENTS AT NEOTOMA. Herbert G. Brown (Ohio. Agricultural Experiment Station, Wooster and Ohio State Univ., Columbus). Aug. 1964. Contract AT(11-1)-552. 59p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Neotoma is a small, wooded valley in south-central Ohio with mixed mesophytic and oak forests and open valley bottom. Results are reported from measurements of solar radiation at 3 major stations from April, 1958 through Dec. 1961. (C.H.)

12907 ^{32}P-LABELED SEMEN FOR MOSQUITO MATING STUDIES. David A. Dame and Claude H. Schmidt (Dept. of Agriculture, Gainesville, Fla.). J. Econ. Entomol., 57: 669-72(Oct. 1964).

Increasing interest in the sterile-male technique for mosquito control accentuates the need for more information concerning mosquito mating behavior. Since the use of radioisotopes to label mosquito semen offers a possible approach to the study of mating behavior in the field, an attempt was made to produce and detect radioactive mosquito semen by a simple technique. Late third- and early fourth-instar Anopheles aegypti and A. quadrimaculatus larvae were transferred to solutions containing 0.1, 0.25, or 0.5 μC ^{32}P/ml/larva. Adult emergence was low in A. quadrimaculatus exposed at the 0.5-μC/ml level, but neither species was severely affected by the other treatments. In A. aegypti males more than half the total radioactivity was located in the thorax, with only about 3% in the testes. Of the total radioactivity in males of either species, only a very minor amount reached the spermathecae of mated females. Although detectable, the low radioactivity of the spermathecae necessitated unreasonably long counts in the proportional counter. On the other hand, the radioautographs produced readily visible evidence of radioactivity in A. quadrimaculatus females inseminated with labeled semen. Those that had mated with labeled males were readily identifiable. The radioactive males, in competition with the untreated males, inseminated the same number of females, indicating that the treatment did not reduce vigor of treated males. Attempts to label semen by tagging honey water fed to adult A. aegypti males were unsuccessful even though such males became highly radioactive. Radiophosphorus is apparently more easily incorporated into the sperm cells or seminal fluid during the early stages of spermatogenesis, which occur predominantly in the larval, rather than in the adult stage. It is suggested that detection of labeled mosquito semen by radioautograph could serve as a useful tool in the study of mating activity in the field. (BBB)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 13795 and 13859.

12908 (CEA-R-2590) UNE NOUVELLE MÉTHODE D'ÉTUDE DU MÉTABOLISME DE L'IODE: LA MÉTHODE D'ÉQUILIBRE ISOTOPIQUE. ASPECTS CINÉTIQUES ET QUANTITATIFS OBTENUS CHEZ LE RAT. (A New Method for Studying Iodine Metabolism: The Isotopic Equilibrium Method— Kinetic and Quantitative Aspects [of Measurements] Made on Rats). Claude Simon (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 84p. Dep.(mn).

Thesis submitted to Université, Paris.

An isotopic equilibrium method is described for the study of iodine metabolism in rats. The quantities and concentrations of iodine were measured in the thyroid gland and in the plasma with 0.001 μg of ^{127}I. This sensitivity made it possible to measure pools as small as the iodide and the free iodotyrosines of the thyroid and to demonstrate the absence of free iodotyrosines in the plasma of the normal rat. In vivo, the isotopic equilibrium method made it possible to measure the iodine content of the thyroid gland and to calculate the intensity of this gland's secretion without removing it. By double labelling with ^{125}I and ^{131}I the isotopic equilibrium method made it possible to measure the flux intensity of the intrathyroidal recycling as well as the turnover rates of all the iodine containing compounds of the thyroid gland. For this gland no precursor-product relationship was found between the iodotyrosines (MIT and DIT) and the iodothyronines (T_4 and T_3). The absence of this relationship is due to the heterogeneity of the thyroglobulin turnover. It was shown that there exists in the plasma an organic fraction of the iodine which is different to thyroglobulin and which is renewed more rapidly than in the circulating hormones T_3 and T_4. The isotopic equilibrium method is very useful for series measurements of iodine. It makes it possible to improve the biochemical fractionations by adding carriers without affecting the subsequent ^{127}I measurements. (auth)

12909 (COO-888-42) INFLUENCE OF ROOT TEMPERATURE ON THE ABSORPTION OF FOLIAR APPLIED RADIOPHOSPHORUS AND RADIOCALCIUM (thesis). Richard L. Phillips (Michigan State Univ., East Lansing). 1964. Contract AT(11-1)-888. 128p. Dep.(mn); $3.00 (cy), 3(mn) OTS.

Radioisotopes were used to assess the influence of root zone temperature on absorption and distribution of phosphorus and calcium applied to leaves of bean and pea plants. Absorption and distribution of ^{32}P applied to primary leaves of bean seedlings growing in solution culture at root temperatures of 7°, 13°, 18° and 24°C, increased with increasing temperature. Similar results were obtained with the pea. Calcium was absorbed at higher rates with increasing root temperatures but translocation from the treated leaf was negligible. Simultaneous use of different air and root temperature combinations resulted in a comparable influence of air and root temperatures on foliar absorption of ^{32}P by the bean. Translocation to the root, however, was greater at the higher root temperature regardless of air temperature. Pre-absorption root temperature affected subsequent absorption of ^{32}P while pre-absorption air temperature did not. Both air and root temperatures had an effect during absorption. (C.H.)

12910 (DPSPU-64-30-7B) SAVANNAH RIVER PLANT WHOLE BODY COUNTER CALIBRATION AND OPERATION. J. R. Watts, S. M. Sanders, Jr., and C. N. Wright (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). May 1964. Contract AT(07-2)-1. 12p. (CONF-642-25). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Health Physics Society, Cincinnati, June 1964.

The Savannah River Plant Whole Body Counter has been calibrated and used in a systematic program to determine whether employees have inhaled or ingested radionuclides in significant amounts. For calibration, the average empirically determined radionuclide distribution in a number of human subjects was used as a model for placing ^{137}Cs and ^{40}K in a plastic manikin. Calibrations for other radionuclides that might be assimilated by employees were also made. Computer analysis of results consists of subtracting ^{137}Cs and ^{40}K from the energy spectrum and solving simultaneous equations for any residual activity. The body burdens of ^{137}Cs, and ^{40}K, and those of 13 other possible radionuclides are automatically printed. Current operation consists of counting groups of employees from the reactor areas, separations areas, the technical laboratory, and a control group from the administration area. Besides the individual analysis, monthly comparisons are made to detect any correlation between work location and radioactive body burdens. Employees involved in contamination incidents are immediately counted. All new and terminating employees are also counted. The Whole Body Counter has been a valuable addition to the SRP health physics program. An immediate determination of the radioactive body burden is reassuring to an employee, whether the count is a result of a possible assimilation or simply part of the routine monitoring program. (auth)

12911 (NP-14752) POSSIBLE COMPETITION BETWEEN LEAVES AND ROOTS OF HERBACEOUS PLANTS FOR ABSORPTION OF RADIOISOTOPES. Progress Report No. 1 and Final Report. G. Barbier and M. Brossard (France. Ministère de l'Agriculture. Station Centrale d'Agronomie, Versailles). [1960]. IAEA Contract No. 16. 16p. Dep.(mn).

Progress is reported in studies on the absorption of ^{137}Cs and ^{89}Sr by the leaves of maize plants and excretion of the radioisotopes through the roots. It was concluded that ^{137}Cs diffuses from the leaves to the roots, but it is halted in the roots unless there is a substantial amount of stable Cs in the growth medium. There is little diffusion of ^{89}Sr from the leaves to the roots. Data are included from a study of the movement of ^{89}Sr and ^{137}Cs through soils and the uptake of the isotopes by the roots of barley plants. Factors affecting the uptake of ^{137}Cs and ^{89}Sr by plants are discussed. (C. H.)

12912 (NP-14761) THE UPTAKE OF RADIOACTIVE WASTES BY LOWLAND RICE FROM CONTAMINATED SOIL DUE TO IRRIGATION WATER AND ITS CONTAMINATION. Progress Report No. 1 and Final Report. (Tokyo Univ. Inst. of Plant Nutrition and Fertilizer). [1960]. IAEA Contract No. 23, 44p.

Progress is reported in studies on the behavior of ^{89}Sr and ^{137}Cs in various soil types and the effects of various kinds of fertilizers and irrigation schedules on the uptake of these radioisotopes by rice plants and deposition in rice grain. Results are included from laboratory studies of the soils and fertilizers and studies on the effects of ^{45}Ca on the uptake of ^{89}Sr by rice plants. (C.H.)

12913 (NYO-3396-3) A NEW APPROACH TO NUTRITION, PHYSIOLOGY AND MINERAL CYCLING OF FORAMINIFERA. Progress Report, May 1, 1964–January 30, 1965. John J. Lee (American Museum of Natural History, New York). Contract AT(30-1)-3396. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Tracer technique has proved to be an excellent tool in the study of predator-prey relationships among the foraminifera. More than fifty axenic species of protists including diatoms, dinoflagellates, chlorophytes, chrysophytes, cyanophytes, bacteria, and yeasts were tested as potential food for Allogromia laticollaris, A. ovoidea, A. sp (NF), Streblus beccari, Quinqueloculina spp, Anomalina sp, Elphidium sp, Spiroloculina schultzi, Globigerina bulloides, Globorotalia truncatulinoides. Although many types of potential food are present in the environment, foraminifera select only certain organisms. The yeasts, cyanophytes, dinoflagellates, chrysophytes, and most bacteria tested were not eaten. Selected species of diatoms, chlorophytes, and bacteria were eaten in large quantity. Three additional factors emerged as variables in preliminary experiments: the age of the food organism, the age of the foraminifera or its position in the life cycle, and the concentration of the food. A strong positive correlation was shown between the concentration of food species of algae and feeding of Allogromia laticollaris. A bloom-feeder hypothesis for foraminiferal nutrition is presented. (auth)

12914 (SGAE-BL-6/1964) DIE WIRKUNG VON CYSTEAMIN UND AET AUF DEN SAUERSTOFFVERBRAUCH UND DIE KORPERTEMPERATUR DER MAUS. (Effects of Cysteamine and AET on the Oxygen Demand and the Body Temperature of the Mouse). A. Locker and J. E. Pany (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf and Vienna. Universität). [1964]. 11p. Dep.(mn).

The total O_2 consumption of the mouse, especially in the first ¼ hr after i.p. injection, was reduced by cysteamine (100 to 500 mg/kg) and AET (100 to 250 mg/kg). After higher doses of cysteamine there was an increase of the total metabolism, which has a correlation with the high motor disquiet of the research animal. With AET the O_2 consumption, in extended studies, declined further but was linearly dose dependent at all times. Both substances reduced the body temperature as a function of the dose. The significance of the mechanism of the radioprotection by cysteamine and AET was discussed. (tr-auth)

12915 CUTANEOUS ABSORPTION OF β RAYS EMITTED BY A $^{90}Sr/^{90}Y$ SOURCE. Miguel A. Patetta Queirolo (Universidad de Carabobo, Valencia). Acta Cient. Venezolana, 15: 26-8(1964). (In Spanish)

A study was made of β absorption by the skin of the toad, Bufo marinus. The radiation source was a pure β emitter containing ^{90}Sr in equilibrium with ^{90}Y, the respective radiation energies being 0.61 and 2.18 Mev. This radioactive material was imbedded in molten glass, which when cooled was encased by two sheets of mica to facilitate its use. Absorption curves were determined at increasing distances (1.55 to 12.4 cm) from the radiation source. The apparent mass absorption coefficient (μ) was determined to be 6.99 cm^2/g for Al. For six different samples of skin the average value of μ was 7.36 cm^2/g, which is in agreement with the average for the theoretical values calculated: 7.31 cm^2/g.

The influence of the position of the filter with respect to the source on absorption was demonstrated by the placement of the skin strips between Al filters of 34.0 and 72.4 mg/cm² thickness. This value in the scale of results corresponded very well to the thickness calculated in mg/cm² for the toad skin. The importance of the agreement between the theoretical calculations and the experimental results for control purposes is stressed. Moreover, the calculation of the apparent mass absorption coefficient may be useful in the determination of the thickness of layers of skin using β-ray absorption. (TCO)

12916 ESTIMATION OF FAT ABSORPTION FROM RANDOM STOOL SPECIMENS: MEASUREMENT BY ZIRCONIUM-95 AND IODINE-131. Lorna G. MacDougall (Johns Hopkins Hospital, Baltimore, Md.). Am. J. Diseases Children, 108: 139-43(Aug. 1964).

The random stool method can be used for estimating intestinal absorption and digestion to overcome difficulties involved in obtaining complete stool collections over prolonged periods of time. Thus, assuming uniform intestinal mixing, the ratio of a nonabsorbable indicator to a test substance in the food can be compared with the ratio in the stool. Absorption of the test substance can then be calculated from a single random stool specimen. The application of this method to the study of fat absorption in normal dogs, normal children, and children with malabsorption syndromes is described. Zirconium-95 oxide was chosen as an indicator substance for the following reasons. (1) It is not absorbed from the intestinal tract and does not have the potentially irritant effect of chromium oxide. Its degradation product is niobium which is also nonabsorbable and has a γ spectrum similar to ^{95}Zr. (2) The product can be obtained directly as ^{95}Zr oxide and requires no further chemical preparation. (3) It has a sufficiently long half-life (63 days) to be of practical value in clinical studies. (4) No toxic side-effects have been reported in animals or humans, apart from rare skin sensitivity after prolonged local application. (5) ^{95}Zr has a γ spectrum which would permit analysis in conjunction with ^{131}I, ^{59}Fe, and ^{60}Co using differential counting techniques. In the first experiment ^{95}Zr oxide was used with unlabeled fat to determine uniformity of mixing of ^{95}Zr oxide throughout the stool specimens. Thereafter ^{95}Zr oxide and ^{131}I-labeled oleic acid were used with differential counting techniques. The results showed that in normal dogs and children an estimate of intestinal fat absorption can be made with accuracy from a single stool specimen. If the first marked stool is excluded from the calculations, results obtained by the random stool method show no significant difference from those obtained by chemical analysis of a 48-hr stool collection. The three patients with malabsorption syndromes showed a wider range of results but in each instance the ^{131}I excretion was in excess of that found in normal controls and there was no difficulty in detecting this in a single stool specimen. It is necessary to administer radioactive material over a two-day period, so this test would be limited to use in hospital patients. For metabolic studies, however, it is less time consuming than the standard methods of performing balance studies which require complete three to five-day stool collections and chemical analysis of both food and stools. The disadvantage lies in the necessity of administering radioactive material over a two-day period, although the total radioactive dose is small. In the event that none of the radioactive material was excreted during the two day period, the maximal estimated total-body radiation dose would be 0.263 R. It is concluded that this test is worthy of further trial in children with malabsorption syndromes and could also be applied to the study of both iron ^{59}Fe and cyanocobalamin (vitamin B_{12})–^{60}Co absorption. (BBB)

12917 ON THE LACK OF SELECTIVITY OF THE FUNCTIONAL RESPONSE OF THE PARATHYROID TO VARIATIONS IN THE BLOOD CONCENTRATION OF TWO ALKALINE EARTH ELEMENTS. L. Tessari (Universita, Milan). Arch. Ortoped., 75: 320-4(1962). (In Italian)

Rats were placed on a Ca-free Kleiber diet for 30 days. After this period they were divided into a Ca-free diet group, Ca-enriched (level of 2.5%), and Sr-enriched (level of 3.5%). They were maintained on this regimen for an additional 20 days. One group of animals was kept as controls on a normal diet for the entire 50-day period. At the end of this period parathyroid activity was evaluated by cell counts on parathyroid tissue. The following mean cell counts were observed per one-mm² area in the control group, Ca-free, Ca-enriched, and Sr-enriched diet groups: 86.5, 57.7, 84.7, and 82.5. Hyperparathyroidism is accompanied by increased volume of cells with concomitant decrease of number of cells per unit area. The cell count changes in the Sr-enriched animals were of major interest. In these animals, as in the Ca-supplemented rats, the hyperparathyroidism observed after 30 days on a Ca-free diet regressed after receiving the Sr-enriched diet for 20 days. Thus, a functional response of the parathyroid to the blood electrolyte levels was manifested by an element other than Ca, namely Sr. The regression of hyperparathyroidism after the Ca-enriched diet was only slightly greater than after the Sr-enriched diet. It is also pointed out that Sr can substitute for Ca in various other biological systems, such as in blood coagulation, in the contractility of smooth and skeletal muscle, and in central nervous system reactions. It is concluded that parathyroid function can also be governed by an element of the alkaline earth group other than Ca. (BBB)

12918 ON THE PREPARATION OF ^{32}P-LECITHIN AND ^{32}P-CEPHALIN. J. Hoelzl, M. Chatterjee, and L. Hoerhammer (Universität, Munich). Biochem. Z., 340: 400-2(1964). (In German)

A procedure for the preparation of ^{32}P-labeled phosphatides is described. To 50 g of soya beans 5 mC of carrier free ^{32}P-phosphate, dissolved in 5 ml of water, is added dropwise, with stirring. After about 2 hr the liquid is completely drained off. The mixture is then incubated for 48 hr at 37°C to bring about a high level of radioisotope incorporation. To avoid as much degradation of the labeled compounds formed as possible, the beans are then frozen quickly and lyophilized. The neutral fat is removed by homogenizing the beans twice with 250 ml of acetone. The phosphatides are extracted by three 250 ml volumes of a chloroform-methanol (1 : 1) mixture at 30°, 40°, and 50°C, with vibration. These extracts are combined. To remove water-soluble impurities, 375 ml of chloroform are added with enough water to form two phases. The lower phase is removed, and the lecithin and colaminecephalin isolated by means of Al_2O_3 chromatography. A typical yield from this procedure is 120 mg of lecithin with a sp act. of 1.13×10^6 cpm/μmole P, and 40 mg of colaminecephalin with a sp act. of 0.8×10^6 cpm/μmole P. The ^{32}P labeled phosphatidic acids can be obtained by removal of choline from the lecithin by use of phospholipase D. The labeled phosphatides prepared by this method have a high enough specific activity to be suitable for oral administration to animals. This method is not so advantageous for preparation of other phosphatides, because they are present in lower concentrations and their purification is more lengthy, so that physical decay of the radioisotope becomes an important factor. (BBB)

12919 THERMAL DENATURATION OF DNA IN HEAVY WATER. V. V. Grechko, L. S. Shkarenkova, and Ya. M. Varshavskii (Inst. of Radiation and Physical-Chemical Biology, Moscow). Biochemistry (USSR) (English Transl.), 28: 786-90(Nov.-Dec. 1963). Translated from Biokhimiya, 28: 1059-64(Nov.-Dec. 1963).

Thermal denaturation of DNA was studied in neutral solutions of 0.15 M NaCl prepared on ordinary and heavy water (99.8 at. %). There was no difference in hypochromic effect between these solutions either in the level of maximum hyperchromism or in the melting temperature (T_m). However, a comparison of the melting curves assayed by the change in the viscosity of DNA solutions disclosed a substantial difference in the course of the curves. This difference indicated an increase in thermal stability of DNA dissolved in heavy water. The difference noted did not disappear upon

a 100-fold decrease in the solution ionic strength. At pH 3.0, DNA proved to be more heat resistant in ordinary water than in heavy water. (auth)

12920 IODINE METABOLISM IN THE THYROID OF THE RAT. II. IODINE TURNOVER STUDIED BY MEANS OF A DOUBLE LABELLING METHOD USING ^{125}I AND ^{131}I. Claude Simon, Claude Benabdeljlil, and Serge Lissitzky (Institut National d'Hygiene, Marseille and Centre d'Etudes Nucleaires, Saclay, France). Biochim. Biophys. Acta, 93: 509-20(Dec. 9, 1964). (In French)

The turnover of all the known iodo compounds of the rat thyroid gland was followed after injections of tracer doses of ^{131}I in rats previously brought into isotopic equilibrium with ^{125}I. Both dialysable and non-dialysable iodine compounds were investigated. No precursor–product relationship was found between the iodo-amino acid residues (3-iodotyrosine (MIT), 3,5-diiodotyrosine (DIT), 3,5,3'-triiodothyronine (T_3) and thyroxine (T_4)) of thyroglobulin. The results found are compatible with the following mechanisms: MIT and DIT are synthesized by direct iodination of thyroglobulin. T_4 is produced by coupling of 2 DIT molecules, and T_3 by coupling of 1 MIT molecule and 1 DIT molecule. The mechanism of biosynthesis of the iodothyronines remains to be elucidated, but T_3 is not produced by the deiodination of T_4. Thyroglobulin is heterogeneous with respect to iodine turnover of each of its four iodinated amino acids. The data concerning iodotyrosines turnover may be interpreted according to the scheme proposed. (auth)

12921 THE USE OF RADIOISOTOPES IN STUDIES OF FOLIAR ABSORPTION. Julio Lugo Caja. Bol. Junta Control Energia At. (Peru), 9: No. 49, 89-104(Apr.-June 1964). (In Spanish)

A bibliographic review was made of tracer studies in investigations on foliar absorption. The mechanism of foliar absorption, the utility of radioisotopes as tracers, classification of nutritional elements, factors affecting foliar absorption, points of nutriment uptake by the leaf, and conditions for the selection of a good tracer are discussed. (J.S.R.)

12922 ON THE ALBUMEN SECRETION IN THE LAYING HEN. II. THE ADDITION OF MINERAL ELEMENTS INTO THE ALBUMEN DURING THE PASSAGE OF THE EGG IN THE OVIDUCT, IN SPECIAL REFERENCE TO ^{131}I. Masaharu Oshima, Midori Suzuki, and Hiroshi Nozaki. Chikusan Shikensho Kenkyu Hokoku, No. 1, 161-8(Feb. 1963). (In Japanese)

A study was undertaken to clarify the change in the amount of ^{131}I that is transferred to the albumen of the egg passing various parts of the oviduct. Nineteen White-Leghorn hens were injected intravenously with μC of Na ^{131}I. The time of injection was determined so as to cover various stages of egg white formation in the oviduct according to the time lapse of the egg's passage through it after oviposition. All the ^{131}I found in the albumen was in the inorganic form. Accordingly, it is known that ^{131}I is transferred to the albumen with water at any stage of the egg's passage in the oviduct. Assuming that the level of ^{131}I concentration in the blood remains unchanged during the passage of an egg through the oviduct, the proportional amount of ^{131}I transferred from various parts of the oviduct was calculated. In the magnum about 20%; ithmus, 10%; and in the uterus 70%. During about 3 hour's period after the entry of an egg in the uterus, about 37% enters with much quantity of water, which doubles the amount of albumen during this time. There are three different modes of entrance of ^{131}I into the albumen from the oviduct. The first one occurs in the magnum and ithmus, where ^{131}I enters with only a little amount of water. The second occurs at the early stage in the uterus, where ^{131}I enters with much quantity of water through the shell membrane. The third occurs at the late stage in the uterus, where a small amount of ^{131}I diffuses into the albumen through the cell. (P.C.H.)

12923 DETERMINATION OF THE ENDOGENOUS CALCIUM IN THE EXCRETA OF THE LAYING HEN AND SOME FACTORS INFLUENCING ON IT. Masaharu Oshima and Hiroshi Nozaki. Chikusan Shikensho Kenkyu Hokoku, No. 5, 27-38(Mar. 1964). (In Japanese)

The endogenous calcium (fecal endogenous and urinary calcium) in the excreta of laying White Leghorn hens was determined by the dilution analysis of ^{45}Ca, and the influence of ambient temperature and dietary calcium upon it was studied. Six White Leghorn hens of which laying rate was about 80%, were kept in an air conditioned room adjusted at 20°C temperature and 75% humidity for 2 weeks in one experiment. After a week interval, the condition was changed to 30°C, 65%, and the second experiment was carried out. The three hens were fed only with a commercial diet containing 2.30% calcium and ample vitamin D (moderate Ca group), and other three hens were given oyster shell in addition to the above diet separately (high Ca group) under each environmental condition. The oyster shell supplement raised the percentage of calcium in the diet consumed from 2.30 to 3.37% on average, and Ca : P ratio from 3.15 to 4.73. The amount of endogenous calcium in the excreta (per hen per day) of each group was: 127 mg in 20°C-moderate Ca group, 184 mg in 20°C-high Ca group, 135 mg in 30°C-moderate Ca group, and 214 mg in 30°C-high Ca group. There was no significant difference in the endogenous calcium level between the two temperature levels, but a significant difference was found between the two dietary calcium levels ($P \div 0.05$). The percentage of the endogenous calcium in the total calcium of excreta in each group was: 19.8% in 20°C-moderate Ca group, 10.1% in 20°C-high Ca group, 28.6% in 30°C-moderate Ca group, and 15.9 percent in 30°C-high Ca group. There was a significant difference in the percentage between the two temperature levels ($P < 0.01$) and also between the two dietary calcium levels ($P < 0.01$). The endogenous calcium in the excreta on the days of laying and pause did not differ distinctly judging from the change of the total daily amount of ^{45}Ca in the excreta. The urinary calcium was determined by extracting filter paper pieces which had absorbed liquid portion of the excreta under the cage. It amounted to about 30 to 40% of the total endogenous calcium in the excreta. (P.C.H.)

12924 THE EFFECT OF AMINOALKYLPHOSPHINIC ACIDS (AAPA) ON EXPERIMENTAL BERYLLIUM POISONING. O. G. Arkhipova, T. A. Kochetkova, M. V. Rudomino, T. Ya. Medved, and M. I. Kabachnik (Inst. of Industrial Hygiene, Academy of Sciences, USSR and Inst. of Metal Organic Compounds, Academy of Sciences, USSR). Dokl. Akad. Nauk SSR, 158: 1235-7(Oct. 11, 1964). (In Russian)

A lethal dose of $BeCl_2$ was administered intraperitoneally to white rats (dose of 3 mg/kg) and to white mice (dose of 36 mg/kg). Part of these animals served as controls and some of the animals were given a complexing agent administered intraperitoneally in order to speed the elimination of beryllium from the organism. The disodium salt of ethyleneaminobisisopropyl phosphinic acid (compound I), ethylenediaminomethyl phosphinic acid (compound II), and the disodium salt of N', N''-dicarboxylmethylethylenediaminobismethyl phosphinic acid (compound III) were used as the principal complexing agents. Compound I increased the survival from zero to 90% when given at a dose of 500 mg/kg to white rats. The best results were obtained when sodium citrate was given at a dose of 250 mg/kg along with compound I (100% survivals in white rats), although sodium citrate was ineffective when given by itself (no survivals). Pyridoxine at a dose of 125 mg/kg, and glucuronic acid reinforced the protective action of compound I. A pathological examination of the internal organs showed signs of excessive bleeding in the liver, kidneys, spleen, heart, and lungs. The signs of damage were less severe on administration of the complexing agent. The soluble complexes of beryllium are less toxic and can be eliminated from the organism. (TTT)

12925 CORRELATIVE EFFECTS OF PUROMYCIN ON ^{131}I METABOLISM AND AMINO ACID INCORPORATION BY CALF THYROID SLICES. Peter V. Tishler and Sidney H.

Ingbar (Boston City Hospital and Harvard Univ., Boston). Endocrinology, 76: 295-300(Feb. 1965).

In an effort to determine whether the iodination of tyrosyl residues of thyroglobulin occurs before or after protein synthesis in the biogenesis of thyroid hormones, the effects of puromycin on the organification of iodide and on protein synthesis were compared in slices from calf thyroid glands in vitro. A concentration of 3×10^{-5}M puromycin inhibited the incorporation of L-leucine-1-^{14}C into thyroprotein, including thyroglobulin, almost completely, but had virtually no effect on the formation of protein-bound ^{131}MIT and ^{131}DIT. It is concluded that the iodination of tyrosin occurs within matrix of the preformed thyroglobulin molecule. Higher concentrations of puromycin were found to have an inhibitory effect on the formation of protein-bound iodine similar to that of other compounds which inhibit organic binding of thyroidal iodide. (auth)

12926 DISTRIBUTION AND REMOVAL OF MONOMERIC AND POLYMERIC PLUTONIUM IN RATS AND MICE. J. F. Markley, M. W. Rosenthal, and A. Lindenbaum (Argonne National Lab., Ill.). Intern. J. Radiation Biol., 8: 271-8(1964).

Mice and rats were injected intravenously with monomeric or polymeric ^{239}Pu (IV). Both species deposited about three-quarters of the injected polymeric Pu and about one-third of the monomeric Pu in the liver. In bone, rats deposited approximately twice as much Pu as mice, 12 per cent versus 6 per cent of injected polymeric and about 60 per cent versus 24 per cent of monomeric Pu. By 12 days untreated rats had lost no Pu from bone, but about one-half of the monomeric Pu from liver. By 90 days the rat liver had lost one-half and the mouse liver one-quarter of the deposited polymeric Pu. DTPA-therapy in rats, from the third to the eleventh day, removed about one-half of both forms of Pu deposited in bone. From liver, DTPA removed all but 1.5 per cent of injected monomeric Pu, but none of the polymeric Pu. In rats which received the same experimental regimen, femurs and tibias had the same specific activity. (auth)

12927 A COMPARATIVE INVESTIGATION OF THE PERCUTANEOUS ABSORPTION OF METAL COMPOUNDS IN THE GUINEA PIG BY MEANS OF THE RADIOACTIVE ISOTOPES: ^{51}Cr, ^{58}Co, ^{65}Zn, ^{109m}Ag, ^{115m}Cd, ^{203}Hg. Erik Skog and Jan E. Wahlberg (National Inst. of Public Health, Stockholm). J. Invest. Dermatol., 43: 187-92(Sept. 1964).

The percutaneous absorption of cobaltous, zinc, and cadmium chlorides, and silver nitrate was studied, and comparisons made with previous studies on mercuric chloride, methyl mercury dicyandiamide, potassium mercuric iodide, and sodium chromate. An in vivo isotope technic was used that employed disappearance measurements and organ analysis during a 5-hr period. At least 6 different concentrations of each substance were studied. The relative absorption of the three ^{203}Hg compounds and of sodium ^{51}Cr-chromate increased with increasing concentration to a maximal percentage (3.2–4.5%/5-hr period), which appears to be characteristic of each substance. When the concentration was still further increased, the absorption decreased to less than 1%/5hr. Cadmium (^{115m}Cd) chloride occupies an intermediate position (maximum percentage about 1.8%/5 hr), whereas the mean absorption of cobaltous, zinc, and silver ions was relatively small (<1.0%/5 hr). The absolute absorption of the ^{203}Hg and ^{51}Cr compounds increased with increasing concentration up to a plateau value, which also appears to be characteristic of each substance. One explanation of these differing types of absorption curves at various concentrations is probably the protein-precipitating properties of the metal compounds. Blocking of the sulfhydryl groups does not appreciably influence absorption. The absorption rate of $^{203}HgCl_2$ through the stripped skin of guinea pigs is increased 0 to 7 times over intact skin, whereas that, for example, for Na ^{131}I is increased 50 to 100 times. Consequently, it appears that the obstacle to the absorption of mercury is not due exclusively to the epidermal barrier, but that other factors must also be taken into account. (BBB)

12928 COMPARISON OF ^{99}Mo METABOLISM IN SWINE AND CATTLE AS AFFECTED BY STABLE MOLYBDENUM. M. C. Bell, B. G. Diggs, R. S. Lowrey, and P. L. Wright (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). J. Nutr., 84: 367-72(Dec. 1964).

Results on yearling cattle and growing swine having similar Mo, Cu, and sulfate intakes demonstrated marked species differences in absorption and excretion of ^{99}Mo. The ^{99}Mo from oral doses reached a peak in blood of swine at two to four hr, whereas the average time in cattle was 96 hr. Over 75% of both oral and intravenously given ^{99}Mo was excreted in urine of swine in 120 hr. In contrast, fecal excretion was the main route of excretion in both oral and intravenous doses in cattle with only 15% excreted in urine in 168 hr by intravenously injected cattle. Added stable Mo increased urinary ^{99}Mo excretion in swine but had little influence on ^{99}Mo excretion in cattle. These data demonstrate a definite species difference and support the differences in toxicity of Mo in swine and cattle. A renal process in swine may be responsible for the rapid urinary elimination of Mo in this species. Fecal excretion of ^{99}Mo by swine was a minor pathway of elimination of both oral and intravenous doses. Stable Mo added to oral doses reduced ^{99}Mo in feces from 15 to 9% showing that absorption was actually increased. This could not be explained as less re-excretion because less than 1% of an intravenous dose was excreted in the feces by either the controls or those given additional Mo. (BBB)

12929 EFFECT OF ARYL ISOTHIOCYANATES ON ^{131}I UPTAKE BY THE MOUSE THYROID GLAND. Bernard A. Becker and Gabriel L. Plaa (State Univ. of Iowa, Iowa City). J. Pharm. Pharmacol., 16: 700-1(Oct. 1964).

Male mice (Swiss-Webster type) were treated orally with 150 mg/kg of α-naphthyl, β-naphthyl, or phenylisothiocyanates. They were then immediately injected with propylthiouracil, 2 mg/mouse, to prevent the binding of ^{131}I by thyroglobulin, and 30 min later treated with 2 μC ^{131}I per mouse. The animals were killed 90 min later, 2 hr after treatment with the aryl isothiocyanates. The radioactivity of the trachea block and of blood was measured, and thyroid (iodide) space was calculated. Phenylisothiocyanate and β-naphthylisothiocyanate did not significantly alter thyroid space. However, α-naphthylisothiocyanate enhanced, rather than blocked, iodide uptake by the thyroid. Hence, α-naphthylisothiocyanate apparently alters the blood-thyroid barrier with respect to iodide transport into the thyroid gland in some unexplained fashion. The action of α-naphthylisothiocyanate on the blood-thyroid barrier is rapid since the effect was demonstrable 2 hr after oral administration of the drug. Similar rapidity of α-naphthylisothiocyanate action was also observed with respect to onset of hyperbilirubinemia in mice. Because of this rapid action, experiments on the effects of α-naphthylisothiocyanate on other physiological barriers should be conducted, as well as investigations of the action of α-naphthylisothiocyanate and related aryl isothiocyanates and thiocyanates on the thyroid gland. (BBB)

12930 THE EFFECT OF SEVERAL PHARMACOLOGICAL AGENTS UPON ^{86}Rb UPTAKE BY THE PERFUSED DOG HIND LIMB. Lloyd P. Gabel (Univ. of Manitoba, Winnipeg, Can.), Martin M. Winbury, Howard Rowe, and Robert P. Grandy. J. Pharmacol. Exptl. Therap., 146: 117-22 (Oct. 1964).

A technique for the determination of ^{86}Rb uptake from the arterial blood in a single passage through the femoral vascular bed is described, as well as the effect of several pharmacological agents thereon. Oxygen uptake was also measured to determine the simultaneous effects on transport of a normal metabolite. Agents which caused directionally similar alterations in vascular resistance differed in their effect on ^{86}Rb uptake. Among the vasoconstrictors tested, epinephrine and norepinephrine increased ^{86}Rb uptake, whereas vasopressin decreased ^{86}Rb uptake. Among the vasodilators tested, histamine, nitroglycerin, and pentaerythritol tetranitrate increased ^{86}Rb uptake, whereas acetylcholine decreased it. Alterations in oxygen uptake

always qualitatively followed the changes in ^{86}Rb uptake. Local hypoxia decreased vascular resistance and increased ^{86}Rb uptake. Shock produced by hemorrhage or epinephrine infusion increased vascular resistance and decreased ^{86}Rb uptake. Dose-response related changes in both vascular resistance and percent ^{86}Rb uptake to intraarterial injection of epinephrine and histamine were demonstrated. It is concluded that drugs producing the same effect upon vascular resistance of the hindlimb do not necessarily cause similar changes in ^{86}Rb uptake, and that changes in O_2 uptake are in all cases directionally similar to alterations in ^{86}Rb uptake. The parallelism of the changes in the extraction of ^{86}Rb and O_2 suggests that the ^{86}Rb exchange in the tissue is a measure of a blood-tissue transport function. (BBB)

12931 CALCIUM^{45} TURNOVER IN A MINERALIZING COCCOLITHOPHORID PROTOZOAN. Henry D. Isenberg, Leroy S. Lavine, Melvin L. Moss, Morris H. Shamos, and Heinrich Weissfellner (Long Island Jewish Hospital, New Hyde Park, N. Y.). J. Protozool., 11: 531-4(Nov. 1964).

The addition of ^{45}Ca to cultures of Hymenomonas, a coccolithophorid chrysomonad, cultivated axenically, was used to autoradiographically confirm the intracellular nature of coccolithogenesis. Quantitative studies with ^{45}Ca indicated the greatest activity resides in the intracellular fraction. Age of the cultures at the time of isotope addition did not appear to affect the sp act. of the coccoliths. The coccoliths, enriched with ^{45}Ca, presented an initial specific counting rate of 2600 which diminished to 1980 cpm after 2-week incubation in nonradioactive medium. Exchange between cell-free isotopically enriched coccoliths and the environment was also demonstrated. The findings are discussed especially from the viewpoint that the initial intracellular deposition of $CaCO_3$ onto a preformed organic matrix is considered to be an animal rather than a plant characteristic. These findings with ^{45}Ca suggest that Ca deposition serves as a quasi-detoxifying mechanism for excessive intracellular carbonate. This could explain the previous observations with symbiotic zooxanthellae and reef corals, which indicated that the rate of $CaCO_3$ precipitation is controlled by the removal of H_2CO_3 by carbonic anhydrase providing either CO_2 for photosynthesis or CO_3^{-2} for mineral deposition. (BBB)

12932 RADIOBIOLOGY. [PART] IX. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 18: 80-5(1964). (In Japanese)

Radiation effects on important biological systems are discussed. In carbohydrate metabolism it has been reported that glucose absorption in the intestines of rats is interfered with even at doses as low as 50 R. Liver glycogen content of mice increase greatly with dose, and some investigators attribute this to increased rate of synthesis. Irradiation also decreases the rate of sugar catabolism, interferes with metabolism of fats, and causes blood cholesterol and lipid phosphates to increase. Fats also enter into peroxidation reactions. Radiation affects oxygen absorption and oxidative phosphorylation by adenosine triphosphate. In vivo and in vitro studies of radiation effects on mitochondria are described. The manner in which phosphorylation reactions taking place in cell nuclei are affected by radiation also is described. (TTT)

12933 QUANTITATIVE STUDY OF THE DISTRIBUTION OF ^{198}Au DURING EXPERIMENTAL PLASMOCYTOSIS FROM DDT. D. Giordano and R. Pantaleo (Università, Bari, Italy). Med. Exptl., 10: 245-50(1964).

Studies were carried out in rabbits and rats in which plasmocytosis was induced by intramuscular administration of DDT in an oily suspension, in a dose of 100 mg/kg per day, for 30 days consecutively. The phagocytic activity of the cells of the reticuloendothelial system (RES) was studied by measuring the quantitative distribution of the ^{198}Au in various tissues. In the normal rats (controls), the storage capacity of the RES for ^{198}Au showed its maximum in the liver, followed by the thymus, bone marrow, and spleen. In the rats developing plasmocytosis from DDT the ^{198}Au uptake index of the different organs was less than in the normal rats, with a maximum reduction observed in the bone marrow. In normal rabbits (controls) the storage capacity of the ^{198}Au showed its maximum in the liver, followed by the spleen, bone marrow, and thymus. In the rabbits with plasmocytosis from DDT the storage capacity of the ^{198}Au was noticeably reduced in the spleen, while in the other tissues slight changes were noted compared to those observed in the normal animals. A study carried out on the animals 30 days after the cessation of administration of DDT showed in the different tissues values almost identical to those of the animals not treated with DDT. An evident correlation exists between plasmocytic state of the RES and modification of the storage capacity of the ^{198}Au: that is, a plasmocytic change induced experimentally causes also a modification of the functional activity of the system. (BBB)

12934 THE USE OF RADIOACTIVE ANTIBODIES IN ONCOLOGY. T. A. Kalitina (Inst. of Experimental Clinical Oncology, Medical Academy of Sciences, USSR). Med. Radiol., 9: No. 9, 89-92(Sept. 1964). (In Russian)

Radioactive I compounds with an antibody were used for the first time in vitro by D. Pressman et al. They found that incorporation of ^{131}I in the antibody does not affect the latter's activity. The studies were carried out with the globulin of immune sera on ovalbumin and nephritic tissue. It was noted that after the intravenous injection of the labeled globulin into rats, the ^{131}I was enriched in the kidneys. Such selective enrichment of the labeled antibodies in organs such as kidneys, adrenal glands, testicles or lungs was confirmed by subsequent studies of several researchers, but no antigens were found with a specific localization in the lymphatic tissues. Injection labeled globulin into rats with transplanted Wagner tumor are also resulted in selective localization of the ^{131}I in certain organs. (E. D. Day et al.) used tumor cells from the ascitic liquid of the Murphy lymphosarcoma for the immunization of rabbits. W. Bale et al., prepared immune antisera for the carcinoma of the rat. The localization seems to be a function of the type of the tumor. This selectivity was used therapeutically against fibrinogen. The mechanism of the localization is not yet clarified. (Review article). (TTT)

12935 STUDIES OF INTESTINAL ABSORPTION OF CALCIUM^{45} IN MAN. Joseph A. DeGrazia and Clayton Rich (Veterans Administration Hospital, Seattle). Metab. Clin. Exptl., 13: 650-60(July 1964).

Results are reported on gastrointestinal absorption in 37 tests on 30 fasted subjects. One radioisotope of calcium, ^{45}Ca, was given orally and another, ^{47}Ca, was given intravenously, so that the true absorption could be calculated from the amount of these isotopes appearing in the stools. Completeness of collection was determined by use of ^{51}Cr-labeled erythrocytes as an unabsorbed marker. Normal subjects absorbed 15 to 50% of the dose. Patients with the milk-alkali syndrome and control patients with different diseases, but with normal calcium metabolism and gastrointestinal function, were within the normal range. Subjects with osteomalacia absorbed less than the normal amount. As expected, a high value for absorption was found in a subject treated with vitamin D and in a hypercalcemic subject with Boeck's sarcoid, a disease which simulates vitamin D intoxication. Increased absorption was found also in hyperparathyroid subjects (and reduced postoperatively), which is consistent with clinical and experimental evidence which suggests an effect of parathyroid hormone to increase gastrointestinal absorption of calcium. In the subjects with normal calcium metabolism and gastrointestinal absorptive function, studied under similar circumstances, there was a wide range of ^{45}Ca absorption (15 to 59%). This was not simply the exhibition of day to day variability since duplicate tests showed a significantly smaller variation. The difference between patients may be because of individual traits which operate on gastrointestinal absorption of calcium, such as undetected variation of calcium or vitamin D intake, age, physical activity, adequacy of pancreatic and biliary function, or many other factors. (BBB)

12936 INFLUENCE OF D_2O ON RESISTANCE OF PLANT AND ANIMAL CELLS, CELLULAR MODELS AND ACTOMYOSIN TO SOME DENATURING AGENTS. V. Ya. Alexandrov, V. L. Komarov, N. J. Arronet, E. I. Denko, and M. F. Konstantinova (Botanical Inst., Leningrad). Nature, 205: 286-7(Jan. 16, 1965).

The effects of D_2O on resistance to heating and high hydrostatic pressure were investigated in cells of Campanula perocifolia L. leaf epidermis, in cells of the ciliated epithelium in Rana temporaria plates; and in muscle actomyosin preparations. Thermostability and resistance to high hydrostatic pressure were increased by deuterization in plant cells, in living ciliated cells, and in actomyosin. A complete but reversible stoppage of protoplasmic streaming in cells occurred in D_2O after 5 min at a pressure of 1680 atm and in H_2O after the action of 1500 atm, a difference that was statistically significant. It is concluded that D_2O increases the resistance of isolated proteins and cells to different injurious agents, an effect however that is not universal. (H.M.G.)

12937 AFFINITY OF EXPERIMENTAL CANCER FOR THE UNSATURATED FATTY ACID INDUCED BY X-RAY IRRADIATION ON THE LIVING BODY. PART 2. Takeru Shiaku (Okayama Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 1086-92(Jan. 25, 1963). (In Japanese)

The first report on a study of experimental cancers, OX substance, an unsaturated fatty acid extracted from irradiated rabbit liver, showed that the OX substance labeled with ^{131}I had affinity to cancer cells. Now labeling of OX with ^{59}Fe was done and experiments on the affinity of OX substance for experimental cancers were conducted. First, the H of carboxylic groups in OX substance was substituted by Na in alkaline solution. Then $^{59}FeCl_3$ was added and Na was substituted by ^{59}Fe to give ^{59}Fe-OX. This was brought into suspension by Tween 80 at a concentration of 2.0%. It was very stable and showed little change with time. Eight-week-old hybrid rats were used as experimental animals. Two million Yoshida ascites sarcoma cells were transplanted into their femoral muscles and tumors grown to one-in. size after five days were used. Into these tumors, 0.5 ml of colloidal solution of ^{59}Fe-OX was injected. After sacrifice at various times, the internal organs were removed and counts per 0.5 g were measured by scintillation counter. Each organ was also fixed with osmic acid to make paraffin sections, and after these were stained by hematoxylin-eosin, the fat and tumor cells in tissue were studied. Yoshida sarcoma cells transplanted into femoral intra muscle, took up ^{59}Fe-OX specifically when compared with other organs and the uptake rate increased from three to 12 hr. In tissue sections, fat particles stained with osmic acid were seen in the tumor tissue after the first hour. An increase in degeneration and necrosis caused by OX in tumor tissue was also seen. Partial necrosis was seen in the tumor tissue at 3 hr after treatment with OX. (BBB)

12938 EFFECT OF COLLOIDAL RADIOACTIVE GOLD (^{198}Au) ON YOSHIDA ASCITES TUMOR CELLS. PART I. ON THE DISTRIBUTION OF ^{198}Au, ESTIMATION OF TISSUE DOSE, AND THE RELATION BETWEEN TISSUE DOSE AND HISTOPATHOLOGICAL CHANGES AFTER INTRAPERITONEAL INJECTION. Takeo Mimori (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 1093-1108(Jan. 25, 1963). (In Japanese)

Colloidal ^{198}Au was intraperitoneally injected in normal and tumor-bearing rats. By the scintillation scanning technique and counting the radioactivity of various organs, the distribution of ^{198}Au in various rat organs was studied. Tissue doses due to the injected ^{198}Au and the irradiation dose to Yoshida ascites tumor cells were also estimated, and histopathological changes of these organs were studied. As seen by scintigraphy, ^{198}Au spread rapidly over the whole peritoneal cavity, and the liver was clearly outlined 15 min after injection. Deposits of ^{198}Au were stored mainly in liver, greater omentum, and in mesenterium. Ascites fluid contained about 10% of injected amount of radioisotope. The estimated tissue doses during 10 days after injection of 1.0 mC of ^{198}Au were about 3620 Rad in liver, 3020 Rad in spleen, 1030 Rad in kidney, and 6200 Rad over the entire serous surface of the intestine. Radiation doses to Yoshida ascites tumor cells were estimated to be about 1520 to 3040 Rad per day. (BBB)

12939 CORRELATION OF ^{89}Sr ELIMINATED FROM THE BONES OF THE LAYING HEN WITH THE EGG. Masaharu Oshima and Hiroshi Nozaki. Nogyo Gijutsu Kenkyusho Hokoku, Chikusan, No. 21, 9-18(Mar. 1962). (In Japanese)

Eleven white leghorn hens, about 8 months old, were injected with $^{89}SrCl$ (37.2 μC) intramuscularly. All the hens were slaughtered on the fourth and ninth day after the injection and the amount of ^{89}Sr in bones and egg shells was compared. It was found that the amount of ^{89}Sr deposited in the bones was distinctly influenced by egglaying. The value of $^{89}Sr/Ca$ in the bones of the four laying hens that laid three eggs each during four days was only 52.8% of that of the four prelaying hens on the fourth day after the injection. In the beginners that started laying on the third, fifth, or eight day after the injection and laid five, four, or two eggs during the experimental time, the more eggs were laid, the less was the $^{89}Sr/Ca$ value in the bones on the ninth day. The value of the specific activity was 0.38, 0.45, and 0.70 μC/g, respectively. In the laying hens whose laying-rate was about 75%, the $^{89}Sr/Ca$ value of the bones decreased to 47% on the ninth day, as compared with the value on the fourth day after the injection. The decrease was almost corresponding to the decreasing rate of the ^{89}Sr amount in the hens' bodies in the same period. Therefore it could be said that the retained ^{89}Sr in the body might behave like Ca in the laying hen. In the beginning of laying, the decreasing rate of the $^{89}Sr/Ca$ value was almost the same in all kinds of the bones, but in the laying hen the rate in the femur was considerably larger than that of other bones. It seemed that the femur might play the leading role to deliver the shell Ca in the laying period. In the end period of the experiment, the average value of $^{89}Sr/Ca$ of the egg shells corresponded to 71% of that of the bones in the laying hens, but in the beginners it was about 114%. (P.C.H.)

12940 BERYLLIUM LUNG DISEASE AND ITS REGISTRY. Howard S. Van Ordstrand, Joseph M. DeNardi, and John F. Zielinski (Western Reserve Univ., Cleveland). Postgrad. Med., 36: 499-504(Nov. 1964).

The characteristics of beryllium lung disease are described with reference to 174 cases (93 acute, 81 chronic). The acute form of the disease is characterized histologically by predominantly intraalveolar mononuclear infiltration, whereas the chronic form is predominantly interstitial and granulomatous. The clinical pictures are also different. In beryllium disease the principal effects are on skin and respiratory tract, and include acute lung disease (acute chemical pneumonitis), chronic lung disease (berylliosis), and dermatitis. Soluble salts of Be may cause dermatitis on skin contact. There is no record of illness resulting from the ingestion of Be. Symptoms of acute chemical pneumonitis may appear within 72 hr after brief but large exposures or, two to three weeks after prolonged exposure to smaller concentrations. The disease is characterized by progressive, spasmodic cough, progressive dyspnea with sensations of tightness of the chest and substernal burning, anorexia with ensuing weight loss, general malaise, and weakness. Total duration of the acute disease from onset of symptoms to complete recovery may be a few weeks to four months. Berylliosis, characterized clinically by various degrees of pulmonary insufficiency, is due to chronic inhalation of Be dust or fumes. The latent period between termination of exposure to Be and onset of clinical disease has a wide range, between one yr and 20 yr. The histologic feature in the lungs is the diffuse chronic interstitial granulomatous pneumonitis, in some instances indistinguishable from sarcoidosis. Tests that aid in differential diagnosis are patch tests with Be compounds and the Kveim test. The Kveim test is negative in berylliosis whereas the Be patch tests are negative in sarcoidosis. The authors' 20-yr experience with chronic beryllium lung disease consisted of

treatment of 81 patients. Twenty-eight were employed in plants engaged in extracting Be from the ore, and 20 had chronic lung disease related to nonoccupational exposures including neighborhood air pollution and clothing worn by Be workers. Twelve of the 81 patients died, but only two deaths occurred since the institution of steroid therapy. (BBB)

12941 OVARIAN FIXATION OF THYROXINE ^{131}I. M. B. Yatvin and J. H. Leathem (State Univ., New Brunswick, N. J.). Proc. Penn. Acad. Sci., 37: 31-3(1963).

Since the accumulation of iodine by the ovary appears to be related to physiologic state, a study was made of the effect of hypothyroidism, gonadotrophin treatment, and the combination of hypothyroidism and gonadotrophin on the ovarian accretion of ^{131}I-labeled thyroxine(T_4). Hypothyroidism resulting from thiouracil feeding for 15 days was associated with a significant increase in ovarian uptake of T_4-^{131}I in comparison with euthyroid control rats. However, the ovaries from rats fed thiouracil for 30 days no longer exhibited an increased capacity to take up T_4-^{131}I. In fact, the ovaries from both euthyroid and hypothyroid rats fed for 30 days actually incorporated less ^{131}I than the euthyroid rats fed casein for 15 days. Ovarian fixation of isotope was significantly increased in euthyroid rats fed casein for 15 days and injected with human chorionic gonadotrophin (HCG) during the last 5 days. Extending the treatment of HCG to 20 days provided ovaries in which T_4-^{131}I uptake did not differ from euthyroid controls. The incorporation of ^{131}I was significantly greater in ovaries from rats treated with HCG for 5 days than in those treated for 20 days. Thiouracil feeding for 15 days associated with HCG treatment during the last 5 days resulted in an increased uptake of T_4-^{131}I by the ovaries. The per cent uptake while greater than in tissues from euthyroid-HCG treated rats was nevertheless not as great as in the ovaries from rats given thiouracil only. After 30 days of thiouracil feeding and 20 days of HCG administration, the cystic ovaries exhibited an incorporation of ^{131}I that was less than euthyroid or hypothyroid rat ovaries but equaled those of euthyroid-HCG-treated ovaries. (BBB)

12942 TRANSPLACENTAL PASSAGE OF THYROXINE AND IODINE^{131} IN THE SOW, EWE, FERRET, GUINEA PIG, AND RAT. A. N. Contopoulos, M. Ryan, C. Rebecca Contopoulos, and E. C. Amoroso (Royal Veterinary Coll., London). Proc. Zool. Soc. London, 142: 699(June 1964).

Thyroxine-^{131}I or inorganic iodine-131 was injected intravenously into the maternal circulation of pregnant animals at various times during gestation. Fetal and maternal blood was obtained 5, 15, 30, 60, 90, 120, 180, and 240 min later and analyzed for total radioactivity and for the presence of different radioiodine components by paper chromatography. Amniotic and allantoic fluids were also obtained and analyzed. No thyroxine-^{131}I was found in fetal pig blood or allantoic and amniotic fluids, after injection in the mother on the 32nd to 80th days of pregnancy. Inorganic ^{131}I was found in the fetal blood within five min after the injection and the concentration per ml blood increased to $\frac{1}{3}$ that found in the maternal circulation at the end of the fourth hr. Large amounts of radioactivity were found in the allantoic fluid within 15 to 30 min after the injection, but very little was found in the amniotic fluid. Fetal urine contained amounts similar to those found in the fetal circulation. Similar results were obtained in sheep. In the ferret, transfer of thyroxine occurred from maternal to the fetal circulation as early as 60 min after the injection. Inorganic ^{131}I crossed the placental barrier and was present in the fetal circulation in concentrations similar to or exceeding those found in the maternal circulation. Allantoic fluid contained radioactivity, but less than $\frac{1}{3}$ that in the fetal circulation. In the guinea pig and the rat, thyroxine-^{131}I crossed from the maternal to the fetal circulation within five min. Inorganic ^{131}I crossed the placental barrier in the guinea pig and the rat within five min and it was concentrated at a higher level than that found in the maternal circulation. This higher amount of radioiodine was maintained on the fetal side for as long as 18 hr after the injection. Within five min after the introduction of ^{131}I-labeled thyroxine into the peritoneal cavity of fetuses in the rat, radioactivity was present in the maternal circulation. Most of it was in the form of thyroxine-^{131}I. (BBB)

12943 THE USE OF B.A.L. FOR THE RAPID ELIMINATION OF RADIOACTIVE MERCURY. EXPERIMENTAL STUDIES IN THE RAT. C. Martinenghi and A. Riccardi (Universita, Milan). Radiol. Med. (Turin), 50: 1256-64 (Dec. 1964). (In Italian)

By means of a series of scintigrams taken up to 24 hours after endoperitoneal injection of Chlormerodrin tagged with radiomercury in rats, it was found that fixation of the tracer in the kidneys is practically complete after 30 minutes. The curve of renal elimination of radiomercury was then determined through external measurements repeated up to the 16th day, and it was observed that the renal radioactivity falls to approximately 50% in 48 hours, and is still higher than 30% after 120 hours. Intramuscular injection of 5 mg of BAL performed 90 minutes after administration of the radiomercury compound determined rapid elimination of over 70% of the radiomercury fixed in the kidneys. It therefore appears that BAL could be used to reduce the radiation dose at the kidneys in renal scintigraphy with radioactive mercurials. (auth)

12944 STUDIES ON IODINE METABOLISM IN THE THYROID GLAND UNDER HYPOTHERMIA. Kenji Matsuhashi (Tohoku Univ., Sendia). Tohoku Igaku Zasshi, 67: 459-75(Apr. 1963). (In Japanese)

Uptake of ^{131}I was determined in rabbits subjected to hypothermia. Chromatographic analysis of hormone in thyroid tissues was carried out along with the determination of 2-hr value of ^{131}I uptake, immediately after hypothermia and 6 and 12 hr, and one, two, three, five, and seven days later. The ^{131}I was injected intravenously into the animals 2 hr prior to resection of the thyroid glands. Thyroid function was also studied in patients with hyperthyroidism during hypothermia and ether anesthesia. Inhibition of the synthesis of thyroid hormone was extremely mild and of short duration under general anesthesia with ether. The inhibitory effect of hypothermia on the thyroid function was seen for a period of five days following anesthesia. The inhibitory effect was most predominantly up to 6 hr after induction of hypothermic anesthesia. Marked alterations of ^{131}I uptake and hormone synthesis of the thyroid gland were observed in the rabbits 12 to 48 hr after hypothermic anesthesia. In comparison with the control group, hypofunction of the thyroid gland was seen. Recovery of the thyroid function was slow, but uniform two to seven days after hypothermic anesthesia. In the clinical studies, severely ill patients were included in the hypothermic group. Inadequacy of the preoperative management with methylmercaptoimidazole was shown by the analysis of hormone synthesis of the thyroid gland. Despite this, the lowering of the synthetic action of the hormone was noted in contrast to the group with ether anesthesia. Hypothermia was effective in terms of the palliation of surgical stress among the patients with hyperthyroidism untreated or inadequately treated preoperatively. (BBB)

12945 DECORPORATION OF METAL IONS BY COMPLEXING AGENTS. A. Catsch (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrum, Karlsruhe, Ger.). p.210-21 of "Essays in Coordination Chemistry. Exper. Suppl. IX." Basel, Birkhäuser Verlag, [1964]. (In German) (KFK-237)

A summary is presented of the theoretical and experimental studies made on the decorporation of metal ions from animal tissues by complexing agents. (J.S.R.)

12946 CYTOLOGICAL EFFECTS OF TRITIATED WATER (THO) ON ROOT-TIP MERISTEMS OF ALLIUM CEPA L. G. Wittmer (Laboratorio di Genetica dell'Istituto Sperimentale Tabacchi, Rome). 11p. (CONF-241-3)

From 11th International Congress of Genetics, The Hague, Sept. 1963.

Series of onion bulbs were grown in tritiated water having specific activity of 2.5 mC/ml; the dose adsorbed

by roots was calculated to be about 32 Rad/hr. Cytological examinations were performed during the treatments and also at different times from exposure to THO. Progressive mitoinhibition, which was lethal, was found after 42-48 hr. The physiological effect on the chromosomal matrix (stickiness) was limited to the first 4 hr of treatment. Strong direct effects on mitotic chromosomes, i.e. a high frequency of chromosome breakage, were found; anaphases with fragments after 24-32 hr. At this time also metaphases showed fragments, which were nearly always acentric and free, rarely attached. Chromosome-breakage (about 2 breaks per cell) was never followed by reunions, and consequently, by visible chromosome exchanges. Only one sure chromosome rearrangement, a dicentric one, was found. The results are discussed in comparison with an analogous one. (P.C.H.)

Radiation Effects

Refer also to abstract 13135.

12947 (CONF-801-2) FACTORS AFFECTING THE RESPONSE OF PROTEINS TO VARIOUS RADIATIONS. Leroy Augenstein (Michigan State Univ., East Lansing). [1964]. Contract AT(11-1)-1155. 13p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

From Panel on the Molecular Basis of Radiosensitivity, Vienna, Nov. 1964.

Results of a literature survey on the response of proteins to ionizing and ultraviolet radiations seem to provide clear evidence of the wide variety of radiation sensitivities observed in proteins. In one series of experiments, it has been shown that the extent of damage which is detected depends upon the treatment administered subsequent to irradiation and also in some cases upon the type of biological activity which is tested. Consideration of amino acid analyses and the specificity of cystine disruption seems to indicate that the radiation sensitivity of individual residues within an enzyme differ and probably depend upon the internal organization of the macromolecule. Presumably the nature of this organization affects energy and charge migration and the sites of ultimate localization of radiation damage. Evidence that there is not only extensive intramolecular but also intermolecular migration of charge and excitation energy has been provided by studies in which additive molecules are present during irradiation and also studies at different temperatures. These results seem to clearly indicate that not only at the molecular level, but even at the level of individual residues within a protein there are marked differences in radiation sensitivity. These results serve to indicate the difficulty of understanding the factors which affect the radiation sensitivity of whole cells. At the same time they suggest that studies at the molecular and submolecular level may be particularly fruitful in ultimately understanding this very complicated phenomenon, which is of critical importance in radiation biology. (35 references.) (C.H.)

12948 (CONF-801-3) FACTORS WHICH MAY INFLUENCE CELLULAR RADIOSENSITIVITY. Leroy Augenstein (Michigan State Univ., East Lansing). [1964]. Contract AT(11-1)-1155. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From Panel on the Molecular Basis of Radiosensitivity, Vienna, Nov. 1964.

The investigations by Sparrow and his group of the inverse corelation between average chromosome volume and the dose required to produce lethality or growth inhibition in woody and herbaceous plants represent some of the most extensive studies of the functional relationship between a biological parameter and radiation sensitivity. Their results suggest that radiation effects can migrate rather extensively through the nuclear sap surrounding interphase chromosomes so as to cause genetic damage. The results of Zirkle indicate that even UV absorbed in the cystoplasm can cause subsequent nuclear effects. However, the results available are not adequate to allow a determination of whether the principal genetic effects result from a distortion of general nucleic acid synthesis or from a direct modification of nucleic acid which is to be duplicated. It is also uncertain whether charge and/or excitation energy becomes preferentially localized in the nucleic acid, protein, or lipid components of chromosomes. At least in dried enzyme-nucleic acid mixtures, the net flow of radiation effects in or out of the protein depends on the pH. These and other studies indicate that the radiation sensitivity of molecules in solution, in gels, adsorbed at interfaces, or in dried preparations may differ by orders of magnitude depending on the environment surrounding the molecules. The serious problems which will be encountered in accurately identifying the factors which control the radiation sensitivity of different molecules in a cell are illustrated by the x ray inactivation of trypsin in agar gels: in even this two component system, three classes of molecules can be readily characterized. Perhaps the greatest impediment to a thorough understanding of radiation sensitivity, is the absence of clear-cut evidence as to which initial interactions and which migration events are crucial to biological inactivation. (auth)

12949 (CONF-640609-1) GENERALIZATIONS DERIVED FROM RADIOBIOLOGICAL EXPERIMENTS WITH MAMMALIAN CELLS IN VITRO. Paul Todd, Robert Tym, John T. Lyman, and Cornelius A. Tobias ([California. Univ., Berkeley. Lawrence Radiation Lab.]). [1964]. Contract [W-7405-eng-48]. 21p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From Society of Nuclear Medicine 11th Annual Meeting, Berkeley, Calif.

The effects of graded radiation doses from heavy ion beams on the colony-forming ability of human kidney cells in tissue cultures were studied under varying conditions of linear energy transfer, anoxia, and potentiation of radiation injury by preincubation in 3-iododeoxyuridine. Both reversible and irreversible effects were demonstrated. Possible applications of the findings to radiotherapy are discussed. (C.H.)

12950 (COO-1095-3) A STUDY OF THE EFFECT OF IONIZING RADIATION ON RESISTANCE, GERMINATION, AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B, AND E. Final Report. J. T. Graikoski and L. L. Kempe (Michigan. Univ., Ann Arbor. Coll. of Engineering). Dec. 1964. Contract AT-(11-1)-1095. 115p. Dep.(mn); $4.00(cy), 2(mn) OTS.

Human botulism has been reported to result from eating fish and seafood products in which Clostridium botulinum Types A, B, and E have grown. With one exception, all known cases of Type E botulism have resulted from eating fish, fish products, and sea mammals. To date, Type E botulism as transmitted by fishery products has resulted in 81 outbreaks involving 432 cases and 125 deaths. Results are reported from a study of the effects of thermal heat and γ radiation on the resistance, germination, and toxin synthesis of Clostridium botulinum spores, Types A, B, and E in various seafood products. Spores were inactivated within 10 min at temperatures of 70 to 90°C. Gamma radiation had some effect on the germination and subsequent growth of the spores. Procedures are included that were used for the isolation of Clostridium botulinum from fish from Lake Michigan. (40 references.) (C.H.)

12951 (D1-82-0362) THE RADIATION DOSE ACCUMULATED BY BLOOD DIVERTED THROUGH A SHUNT. Mathematical Note No. 357. George Marsaglia (Boeing Scientific Research Labs., Seattle). July 1964. 12p. (AD-605573). $1.00(OTS).

Modern techniques have made it possible to divert a portion of the circulating blood through a shunt outside the body, for example in heart-lung machines, artificial kidneys, and coiled tubes where the blood may be exposed to radiation without danger to body tissues. There is some probability theory connected with such procedures, for the cells of the blood are thoroughly mixed in the body, and

hence the number of times a blood cell passes through the shunt is a random variable. Several papers have been written to describe such systems by differential equations; this paper discusses the problem directly in terms of probability theory, finding the exact distribution of the number of times a blood cell has passed through the shunt and, in addition, a normal approximation which makes calculation of accumulated doses a matter of simple arithmetic. (auth)

12952 (DASA-1422) METABOLIC CHANGES IN HUMANS FOLLOWING TOTAL-BODY IRRADIATION. Period Covered: November 1, 1961–April 30, 1963. Eugene L. Saenger (Cincinnati. Univ. Coll. of Medicine). Contract DA-49-146-XZ-029. 65p. (AD-604478). $3.00(OTS).

Metabolic responses were studied for 6 to 8 weeks after the exposure of 19 cancer patients to ^{60}Co γ radiation at doses equivalent to midline air doses of 226 to 336 R. Each patient served as his own control and normal values were established during the 2-week period before irradiation. The parameters studied included clinical findings; medications; complete blood study; chromatographic analysis of urine for amino acids, deoxycytidine, and xanthurenic acid; content of urea nitrogen and creatinine in blood serum; response to a quantitative precipitin test; and chromosome changes in leukocytes. Pre- and post-radiation observations are reported and clinical summaries for 10 individual patients are included. Profile scoring methods used for the evaluation of hematological data are described. Results indicate that the urinary excretion of deoxycytidine and xanthurenic acid, chromosome alterations, and immune responses offer some promise as supplements to blood studies as indicators of radiation damage. (C.H.)

12953 (NP-14664) THE BIOLOGICAL EFFECTS OF VARIATION OF RADIOACTIVITY OF POTASSIUM IN THE PERFUSED ISOLATED HEART. Complete Report. P. Rowinski (Perugia, Italy. Università. Istituto di Fisiologia e Chimica Biologica). Feb. 24, 1962. IAEA Contract No. 52. 35p. Dep.(mn).

Results are presented from a series of studies on the effects of x radiation doses ranging from 10,000 to 55,000 R/min on the physiology of heart of Rana esculenta. It was concluded that the low body temperature and low oxygen content of the blood contributed to the radioresistance noted in the frog heart. Results are also included from studies of radiation effects in isolated, perfused frog hearts. Permeability changes were demonstrated by the addition of ^{86}Rb to the perfusion solution. The effects of the addition to the perfusion fluid of glucose, cysteamine, and sodium thiosulfate on radioinduced changes in permeability were studied. It was concluded that x radiation affected the permeability of cell membranes or had a depolymerizing action on cell macromolecules engaged in the retention of K, that is interchangeable with Rb. (C.H.)

12954 (NP-14665) CHANGES OF THE PERMEABILITY OF THE ISOLATED FROG HEART IRRADIATED WITH X RAYS. PROTECTIVE ACTION OF GLUCOSE, OF CYSTEAMINE AND SODIUM THIOSULPHATE. Second Half-year Progress Report. P. Rowinski, A. Debenedetti, and A. Millo (Perugia, Italy. Università. Istituto di Fisiologia e Chimica Biologica). Feb. 24, 1962. IAEA Contract No. 52. 21p. Dep.(mn).

The isolated heart of Rana esculenta was perfused with Krebs-Ringer solution to which various concentrations of ^{86}Rb were added. The entry and the exit of $^{+86}$Rb into the heart was accelerated by x irradiation. The radiation effect was followed for up to an hour and was detectable after a minimum dose of 10.7 kr for 7 mins, or for a dose of 5.3 kr for 15 minutes. Glucose in the perfusion fluid slowed the entry of Rb into the irradiated heart. Cysteamine and sodium thiosulphate, in concentrations not affecting the heart beat, protect the heart from the permeability changes observed. The action of sodium thiosulphate was more reliable and was detectable at a concentration far below the toxic dose. The action of x-irradiation was tentatively explained by the permeability changes of the cell membrane or by its depolymerizing action on the cell macromolecules engaged in the retention of potassium that is interchangeable with rubidium. (auth)

12955 (NP-14666) [IRRADIATED FROG HEART]. First Half-year Progress Report. P. Rowinski (Perugia, Italy. Università. Istituto di Fisiologia e Chimica Biologica). July 25, 1961. IAEA Contract No. 52. 15p. Dep. (mn).

Progress is reported in studies of the effects of x radiation on the physiology of the frog heart. No change in heart activity or glycogen content was observed when the heart of Rana esculenta was exposed in situ to doses of x radiation ranging from 10,000 to 55,000 R/min. Preliminary results are reported from studies on the effects of radiation on the movement of Rb in isolated, perfused frog hearts. (C.H.)

12956 (NP-14774) CALCULATING ERD DURING A PROLONGED EXPOSURE IN A FALLOUT ENVIRONMENT. Research Memorandum RM-OU-156-6. Joseph Battle (Research Triangle Inst., Durham, N. C.). June 8, 1964. Contract OCD-OS-64-56. 19p.

The equivalent residual dose (ERD) concept proposed by the National Committee on Radiation Protection permits a more reliable prediction of the medical effects of nuclear radiation exposure during emergency conditions. This study describes a simple computer tool for calculating ERD under a variety of fallout conditions, levels of protection, and time-varying exposure patterns. Several applications of the tool are presented. One of the applications is the determination of time saved in the recovery of activities as a function of decontamination. (auth)

12957 (SGAE-BL-10/1964) ATOMENERGIE IN DER ZUCKERRUBENINDUSTRIE. (Atomic Energy in the Sugar-Beet Industry). K. Kaindl and M. Rosner (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf). [1964]. 13p. Dep.

A bibliographic review is given of the studies made on the use of atomic energy in the sugar-beet industry. Investigations in which the ionizing radiation acts as an energy carrier to the irradiated substance and causes modifications in the plant are first summarized. The stimulating and mutagenic effects of radiation and its effects on carbohydrates are discussed. The storage of sugar beets is also considered. Tracer studies made to determine the process of sugar synthesis, the effects of fertilization and soils, and efficiency of the industrial processing are summarized. 55 references. (J.S.R.)

12958 (SGAE-BL-12/1964) VERANDERUNG TECHNOLOGISCHER CHARAKTERISTIKA VON BETRIEBSHEFE DURCH ^{60}Co-BESTRAHLUNG. (Changes in Characteristics of Industrial Yeast by ^{60}Co Irradiation). K. Prosenz, H. Gaisch, and K. Kaindl (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf). [1964]. 16p. Dep.

The effects of ^{60}Co γ radiation at 0.01 to 1 Mrad on the degree of fermentation, pH behavior, CO_2 production, final degree of fermentation, acid content, alcohol formation, yeast mass, fracture capacity, and residual sugar of yeast were investigated. All characteristics were stimulated up to 0.05 Mrad and inhibited at higher doses. The stimulating effect of γ radiation could be more easily detected when the time was a variable. This indicates that a continued acceleration of the processes considered could be produced. (J.S.R.)

12959 (TID-21460) THE EFFECT OF X-RAY IRRADIATION ON THE ENZYMATIC ACTIVITY AND NUCLEIC ACID METABOLISM IN SEEDS AND SEEDLINGS OF ZEA MAYS. R. H. Hageman (Illinois. Univ., Urbana). [1964]. Contract AT(11-1)-791. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results are reported from a series of studies on the effects of the exposure of seeds of soybean and corn to various doses of x radiation on subsequent growth protein synthesis, and enzyme activity in seeds and seedlings. Data are included from studies of metabolic processes involved in normal tissue growth. A list is included of

publications during the period covered by this report. (C.H.)

12960 (TID-21564) RADIOBIOLOGICAL SIGNIFICANCE OF β-AMINOISOBUTYRIC ACID. Final Report, May 1, 1963–April 30, 1964. Henry Lanz (Texas. Univ., Dallas. Southwestern Medical School). Contract AT(40-1)-2731. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A rapid high voltage paper electrophoretic method was developed for the determination of β-aminoisobutyric acid (BAIBA) in urine. Results are reported from the analysis of urine from normal male and female human subjects and patients undergoing radiotherapy for malignancies, normal dogs, dogs exposed to 19 rads/min of fission spectrum neutrons, and rats and guinea pigs exposed to LD_{50} or higher doses of x radiation. It was concluded that BAIBA excretion is much too random to serve as an indicator of radiation injury or the clinical status of patients with neoplasia in the several species studied. (C.H.)

12961 (TID-21604) COMPREHENSIVE FINAL REPORT OF RESEARCH ACTIVITIES, 1958–1963. Otto L. Stein (Massachusetts. Univ., Amherst). Contract AT(45-1)-1302. 43p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Progress is reported in studies on the effects of radiation on plant morphology and practical applications of radiation in problems related to mutation breeding and plant metabolism. Results are reported from studies on the effects of chronic and acute exposure to doses of 330 R/20-hr day or single doses of 200 R x or γ radiation on the development of cells of Kalanchoë plants in air and in various gas atmospheres. A finely focused $^{90}Sr/^{90}Y$ source was developed to restrict radiation exposure to apical meristem cells and results indicate that the phenomena observed in x irradiated plants were the result of insult tc the apical meristem rather than over-all radiation. Data are included on the sensitivity of corn and pea roots to internal nuclear radiation, using tritiated thymidine as the radiation source, the effects of x radiation on the development of corn roots, the effects of a high concentration of heavy water on root elongation and cell division in a monocot, Zea mays, and a dicot, Pisum sativum, and the effectiveness of the induced color chimera system in the assay of mutation treatments in plants. A list is included of publications during the period. (C.H.)

12962 (TID-21611) STUDIES OF THE EFFECTS OF ULTRAVIOLET RADIATION ON CELL STRUCTURE AND BEHAVIOR. Six-year Comprehensive Report, March 1959–November 1964. Jerome J. Freed (Institute for Cancer Research, Philadelphia). Jan. 21, 1965. Contract AT(30-1)-2356. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Design features are described of a vibrating mirror flying spot ultraviolet microscope with incorporated television system. The instrument was designed for use in studies of the effects of ultraviolet radiation in single cells and changes in absorbancy associated with cell growth and mitotic division. The instrument was also used to study the effects of ultraviolet radiation from the microscope on systems within cells. Ascites cells irradiated with the flying spot microscope had a characteristic damage syndrome that was recorded by time lapse cinemicrography and used to determine the severity of the effect. It was established that the sensitivity to ultraviolet radiation was generally distributed through the cytoplasm of the cell, that the action spectrum for production of the effect was probably of the protein type, and that the sensitivity of the cells declined as the tumor grew in the host animal. In similar experiments carried out on cultured cells grown attached to glass, it was found that very small radiation doses interfered with motile behavior and higher doses caused retraction of the cells. The effects of metabolic inhibitors were also studied. Cytological studies were initiated in cultured cells of Rana pipiens and the propagation of Lucké tumor virus in cells in culture. A list is included of publications during the period. (C.H.)

12963 INFLUENCE OF GAMMA RADIATION ON THE NITROGEN FIXATION ACTIVITY OF RIZOBIUM JAPONICUM IN SYMBIOSIS WITH TWO VARIETIES OF SOY BEANS. Eva Hamatova (Central Research Inst. for Plant Production, Prague). Acta Microbiol. Polon., 13: 247-54 (1964).

The influence of γ rays on Rhizobia in vitro and in symbiosis with host plants was studied to determine: whether it is possible to obtain highly active mutants of R. japonicum; whether the soya variety used reacts to the mutants of two different strains of R. japonicum in the same way; and whether two different soya varieties react to mutants of one strain of R. japonicum differently. The examined strains (D 179 and D 387) differed in their sensitivity to ^{60}Co radiation. Survival of strain D 387, after irradiation with doses of 50,000 and 150,000 R, was much higher than in strain D 179, a dose of 150,000 R being lethal for it. Doses 250,000 and 500,000 R were lethal for both strains. Morphologic changes in irradiated (50,000 and 150,000 R) cells were seen; hypertropic, concave bacteroidal forms were observed, and in several cases the morphology of the colonies was also changed. The effects of different mutants of the strain D 179 on two varieties of soya, Kromerizska and Mukden, were also distinctly different. In the soya variety Kromerizska precious yellow inoculated with mutants of the strain D 179, accumulated nitrogen amounted to 1200 mg per plant unit in 35.3% of cases, and exceeded 1200 mg per plant unit in 5.9%. For the Mukden variety of soya, the corresponding values equalled zero and 12.6%, respectively. Inoculation of the Mukden variety was distinctly more effective; in 43.7% of the cases the yield of dry matter amounted to 350 g per plant unit, and in 6.3% it exceeded 400 g per one plant unit. For the variety Kromerizska precious yellow, on the other hand, corresponding values were only 17.7 and 5.9%. With the aim of obtaining extremely active variants of R. japonicum, 14 mutants of strains D 179 and D 387 were selected from among those that gave increased nitrogen and dry matter yield. (BBB)

12964 CHROMATID DELETIONS PRODUCED IN HUMAN CELL CULTURES BY 250 KV X-RAYS AT LIQUID NITROGEN TEMPERATURES. Robert H. Fetner and Allan A. Katzberg (Georgia Inst. of Tech., Atlanta). Aerospace Med., 34: 1115-8(Dec. 1963).

After exposure to 50 to 2000 R doses of x rays the frequency of interstitial chromatid deletions was studied in KB cell cultures irradiated at –190 and 25°C. In unfrozen cells the optimum production of chromatid deletions was 12 hr after irradiation for doses up to 200 R. Between 200 and 400 R, mitotic inhibition was produced which resulted in the max number of chromatid deletions being observed 24 hr after irradiation. This was true to 1000 r, which was the dose tested at 25°C. The production of chromatid deletions as a function of x-ray dose indicated a high positive correlation. There were 4×10^{-5} interstitial deletions/chromosome/r in the unfrozen group. In the cells irradiated in liquid nitrogen, no mitotic inhibition was observed with doses up to 2000 r. The max production of chromatid deletions was at 12 hr after irradiation. Production of chromatid deletions as a function of dose indicated a high positive correlation between these two variables. There were 1.3×10^{-5} interstitial deletions/chromosome/R in the frozen cultures. Thus, cells irradiated in liquid nitrogen are about 1/3 as sensitive to chromosome breakage as cells irradiated at room temperature. These results are discussed in terms of results on other biological systems irradiated at low temperatures. Failure of cells in the frozen state to demonstrate a mitotic inhibition even at very high doses is considered significant. The presence of a threshold value (multihit effect) is interpreted as evidence that it may be the result of an interference with some metabolic process. The protection which the frozen state provides indicates that the mitotic inhibition is a result of events which take place in that part of the cell (possible water) rendered inactive by very low temperatures. It is proposed that frozen human cells may provide a useful time-independent dosimeter which can accumulate radiation over long periods of time and then permit cytologic analysis at the next metaphase. (BBB)

12965 RADIOBIOLOGICAL EFFECTS OF INCOMPLETELY PENETRATING ELECTRON RADIATION. O. M. Meredith, E. G. Bowers, and J. T. Heintzelman (Lockheed Missiles and Space Co., Palo Alto, Calif.). Aerospace Mex., 35: 1028-33(Nov. 1964).

CF_1 mice received local exposure to 1-Mev electrons, delivered at a rate of 3000 Rad/min at doses up to 50 kRad. Skin of the mice was found to attenuate the beam intensity about 50%, thus sparing severe injury to internal organs. Radiation effects following 1500 Rad were: decrease in body weight, alopecia, burns, enlargement of the spleen, and testicular atrophy. The 30-day cumulative mortality values were 50% for dorsal exposure compared with 100% following ventral exposure. After dorsal irradiation there was a significant reduction in spleen weight, which may be evidence of an abscopal effect, since the spleen is beyond the range of electrons hitting the backs of animals. Depression of the intestinal weight due to irradiation of the back was seen, and direct injury could have been responsible for this effect. Changes in total white and red blood cell counts resembled those seen with the bone marrow depression syndrome. When the lateral aspect of animals was exposed to electrons, it was expected that less of the gastrointestinal mass would be affected and, consequently, effects would be reduced. The lethal effect was not reduced, but its character was changed. The animals not dying from the early radiation effects showed a lethal response associated with the burns which developed later. In general, after irradiation of the ventral surface, bone marrow depression or intestinal syndrome was evident in the dose range of 500 to 1000 Rad. For lateral or dorsal exposures, death at minimally lethal levels (1000 to 2000 Rad) was associated with severe burns at 15 to 30 days postirradiation. At high dose levels delivered to the back (10,000 to 20,000 Rad) animals appeared to die of an intestinal injury, while at higher levels, central nervous system-type deaths were seen. Because of the nonapplicability of the RBE concept here, since the electron beam did not irradiate the entire organism at one time during a unilateral exposure, a single RBE value is not attainable. If the concept were applied, the RBE for ventral exposure to 1-Mev electrons (compared to 250-kvp x rays) would be near 1, while the value for lateral or dorsal exposures would be nearer 2 or 3. (BBB)

12966 GAMMA IRRADIATION OF ANAPLASMA MARGINALE. Charles F. Simpson, F. C. Neal, and G. T. Edds (Univ. of Florida, Gainesville). Am. J. Vet. Res., 25: 1771-2(Nov. 1964).

Attempts were made to attenuate A. marginale so as to render it nonpathogenic, yet capable of stimulating protective immunity. Blood of calves with anaplasmosis was exposed to ^{60}Co γ rays at an intensity of 2320 R/min for doses of 4000, 5000, 10,000, 40,000, 75,000, 100,000 or 300,000 R. Splenectomized calves developed severe clinical anaplasmosis following a single injection of irradiated carrier or infected blood treated with levels up to and including 75,000 R. Calves treated with three doses of irradiated blood containing A. marginale reacted similarly at levels up to 75,000 R. The infectivity of acute and carrier blood was destroyed by irradiation doses of 100,000 R or more, as determined by failure of the disease to develop in treated calves during an observation period of 2½ months. Such calves did not develop complement-fixing antibodies to the disease and developed a severe form of the infection following challenge with nonirradiated carrier blood. No alteration of incubation period was noted after injection of irradiated blood. Thus, attempts to modify the virulence of A. marginale and, at the same time, establish protective immunity failed. However, a definite range was found at which the organism was rendered noninfective (e.g., 100,000 R) and below which (75,000 R) the disease-producing ability of the organism was unaffected. (BBB)

12967 ANATOMIC AND CLINICAL COMPARISON OF CHRONIC OCCUPATIONAL RADIODERMATITIDES OF THE HANDS. F. Lagrot, J. Mussini-Montpellier, and R. Streit (Hôpital de Mustapha, Algiers). Ann. Chir. Semaine Hop., 15: 29-41(Jan. 1961). (In French)

A classification is made of the lesions of radiodermatitis based on their anatomical and clinical aspects and their developmental stages as follows: Stage I (initial stage) is marked by trophic disorders, ungual fragility, and a beginning cutaneous atrophy. If radiotherapy is suspended, these lesions will stabilize or regress. Stage II (vasculokeratotic stage) is characterized by an increase in number and density of corneous warts. Stage III (trophic stage) shows hypertrophy and spreading of the keratoses which split and come off, crevices, intermittent ulcerations which become chronic. Stage IV is the cancerous stage. From a surgical view, radiodermatitis presents two distinct forms beginning with Stage II: (1) a microangiectatic sclero-atrophic form in which cutaneous dissection is often difficult because the epidermis becomes adherent to the lower layers through atrophy of the dermis and hypodermis, and (2) a verrucous keratotic pachydermic form which lends itself more easily to surgery but forms corneous keratomas which fissure and give rise to multifocal malignancies. Cancerous changes were seen in 15 of the 31 cases studied, arising from keratomas or ulcerations. Four of the cancers were more severe than the others, with a wider local development, deeper penetration, and multiple sites. A histologic study revealed lymphatic vessels extending the dermis. The greater severity of these four cancers resulted from excessive exposure to irradiation, occupational or therapeutic. A histopathologic study of the epidermal lesions showed all the strata to be injured. The corneous stratum was often thickened, forming ortho- or parakeratomas. The granulosa layer was irregular and atypical cells could be observed. The Malpighian bodies were of variable thickness, sometimes atrophic, sometimes hyperacanthotic. An acidophilic substance appeared at their site. The basal epidermis, site of young dividing cells, is particularly sensitive to irradiation. It can be completely destroyed and infiltrated by a dense dermal growth which erodes the lower strata of Malpighian bodies. In the dermis the lymph and blood vessels become dilated, thick-walled, and impermeable. Circulation becomes deficient, and the dermis becomes sclerotic and atrophies. The follicles and sebaceous glands are also destroyed. Histologists generally recognize only three stages of chronic radiodermatitis: simple radiodermatitis, epithelioma in situ, and overspreading cancer. The third (trophic) stage poses for the clinician the problem of malignant change. (BBB)

12968 CEPHALOPELVIMETRIC RADIOLOGY AND THE ENTITY OF RADIATION DOSES TO THE FETUS AND MATERNAL OVARIES. Ennio Zanetti and Luigi Tosca (Università, Milan). Ann. Ostet. Ginecol., 84: 589-94(July 1962). (In Italian)

Measurements of the radiation dose received by the fetus and the maternal ovaries during diagnostic radiologic examinations were made both in Plexiglas phantoms and in patients with the usual methods. Measurements were conducted during the cephalopelvimetry technique, that is, assessment of the relation between the size of the fetal head and the maternal pelvis. All the measurements were done with two dosimeters, a Simplex and Kondiometer, which allowed recording doses up to 100,000 R of radiation with energy between 8 kev and 2 Mev. Anterior-posterior and lateral projections of the subject were used and the values obtained, near the termination of pregnancy, either with conventional (75 kv) or the hard x-ray (135 kv) technique, were tabulated. With the hard x rays the focus-film distance was three m (teleradiopelvimetry). The values obtained are given in terms of proximal dose, which refers to the maternal ovary that is nearer to the x-ray tube in the lateral projection and distal dose which refers to the other ovary. Dose values for the central part of the fetus, from which any intensity to the fetus reproductive organs can be deduced, are also tabulated. The variability in the results shows, in regard to the mother's ovary position, a large absorbed dose fluctuation. Consequently minimum and maximum values are given in addition to mean values. The following mean values were obtained for anterior-

posterior and lateral positions, respectively, for 75-kv x rays: skin dose 2490, 4660 mR; proximal ovary, 100, 20 (total 120); and center of the fetus 340, 160 (total 500). The corresponding values for 135-kv x rays were: 950, 1020 mR; 60, 540 (600); 60, 15 (75); and 120, 80 (200). The relatively lower absorbed fetal and maternal doses are evident with the hard as compared with the softer x rays. The cautious attitude which is recommended in preventing excessive radiation exposure should not stop the essential diagnostic use of hard radiation which makes it possible to effectively lower the maternal and fetal exposure. (BBB)

12969 THE SURVIVAL OF RENAL HOMOTRANSPLANTS IN DOGS TREATED BY CHEMOTHERAPY, RADIATION, AND CROSS CIRCULATION. H. B. Hechtman, D. A. Blumenstock, J. Mithoefer, and J. H. Powers (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Ann. Surg., 159: 119-24(Jan. 1964).

Radiation, cross circulation, and administration of antimetabolites were assessed singly and in combination for their ability to prolong the life of transplants of whole-kidney in unrelated dogs. Four dogs were given 200 to 317 R of whole-body irradiation the day before receiving a renal transplant, and methotrexate after the operative procedure. One died on the sixth day with an infarcted ileum and a normal transplant. The other died anuric on the 11th day after removal of the remaining normal kidney. When other two animals were given azathioprine, one died on the sixth day of drug toxicity and the other on the 20th day of intussusception. Their renal homografts were normal at post-mortem examination. Methotrexate alone failed to prolong survival of kidney homografts. In fact, methotrexate toxicity was so severe in animals with impaired renal function that dogs with transplanted kidneys failed to survive over five days unless a functioning isologous kidney was left in place. When methotrexate or azathioprine was combined with sublethal irradiation the results were not improved. When fresh unirradiated blood was transferred by transfusion or cross circulation from a normal donor to a recipient treated with drug or radiation, the recipient frequently succumbed to infection or bleeding due to thrombocytopenia. In only one instance did a recipient survive treatment and maintain a homograft. This animal, treated with repeated blood transfusions and azathioprine before transplantation and azathioprine after transplantation, was sustained for 173 days by the function of the transplanted kidney. It was difficult to determine whether this survival was related to the pretreatment program. The transplant was nearly normal at the time of death. (BBB)

12970 GAMETO-, EMBRYO-, AND FETOPATHIES CAUSED BY IONIZING RADIATION. Joseph Weis (Universitat der Saarlandes, Homburg, Ger.). Ann. Univ. Saraviensis Med., 8: 199-246(1960). (In German)

The type of organ system and the degree to which it is affected by radiation vary with the amount, the type, and the period of exposure to radiation. Dosages as low as 40 R may effect changes in some rapidly developing tissues, but for other, more radioresistant tissues as much as 10,000 R may be required in order to obtain a perceptible effect. Some relations of radiosensitivity of specific organ systems in experimental animals and in man are reviewed and compared. In humans, developmental abnormalities caused by ionizing radiation in brain include anencephalus, porencephaly, hydrocephalus, defects of the medulla, increased size of the third ventricle, cerebellar defects, microcephalus, idiocy, and ataxia. Eye defects observed after irradiation include anophthalmia, cataract, coloboma, microphthalamus, lenticular defects and malformations, optic nerve aplasia, chorioretinitis, albuminism, blindness, strabismus, and nystagmus. Several types of developmental anomalies of the skeleton result from exposure to radiation. These include polydactyly, hypodactyly, clubfoot, cranial deformations, gum defects, impairments of odontogenesis, hip joint luxations, and spina bifida. Other, more widespread anomalies and defects may appear in other body areas. These include cardiac anomalies, malformations of the aortic arch, malformations of the auditory musculature, malformed or hypoplastic gonads, hypoplastic kidneys, hypospadias, skin and mucosal changes, and mongolism. (250 references) (BBB)

12971 POTENTIATION OF HYPERPIGMENTATION FROM X-IRRADIATION: EFFECTS OF DEMETHYLCHLORTETRACYCLINE THERAPY. Frank E. Cormia (New York Hospital and Cornell Univ., New York). Arch. Dermatol., 90: 624-5(Dec. 1964).

The development of moderately severe facial hyperpigmentation in a patient receiving both x rays and demethylchlortetracycline for deep pustular acne is reported. The patient, a 22-year-old brunette of Greek extraction, received 600 mg of demethylchlortetracycline daily for one week. X-ray therapy consisted of 75 R weekly to each side of the face, with lead shielding of chest, eyes, and scalp. Two and one-half weeks after the first x-ray treatment, moderate hyperpigmentation was noted over the glabella, nose, and central cheek area. The areas covered by shields did not become hyperpigmented. When demethylchlortetracycline was stopped, while x radiation was continued, the hyperpigmentation faded 50%. Demethylchlortetracycline was resumed, and two weeks later the hyperpigmentation again became pronounced. The antibiotic was discontinued, and the hyperpigmentation faded gradually over a four-week period, despite the continuation of x-ray therapy to a total of ten treatments. The results suggest that this agent had enhanced the pigment-stimulating effect of x-radiation. There was no visible inflammatory response at any time during treatment. (TCO)

12972 OSMOTIC RESISTANCE OF RED BLOOD CELLS IN RABBITS AFTER TOTAL-BODY X IRRADIATION. Stanislaw Kosmider (Silesian School of Medicine, Zabrze, Poland). Arch. Immunol. Terapii Doswialdczalnej, 9: 495-9(1961)

A study was designed to investigate changes concerning the osmotic resistance of red blood cells in the peripheral circulation induced by irradiation with small doses of x rays in rabbits. Experiments were performed with 12 rabbits irradiated once from the dorsal side with doses of 200 and 500 R. The dose rate was 10.6 R/min. Blood samples were drawn from the marginal ear vein, before irradiation and after 3, 10, and 20 days. After washing the red blood cells three times, their osmotic resistance was determined with NaCl solutions of increasing concentrations. The tests were performed at 30°C. In healthy unirradiated rabbits the osmotic resistance of the red blood cells was fairly constant, without significant fluctuations. Beginning hemolysis was observed at concentrations of 0.40-0.44% NaCl, and complete hemolysis at 0.34-0.38% NaCl. In irradiated rabbits the osmotic resistance of the red blood cells was diminished in proportion to the time elapsing and dose of radiation. The results confirm reported changes in the osmotic resistance of red blood cells following massive doses of radiation. The mechanism of the injurious effect of x rays on circulating blood cells is still not fully elucidated, but it is known that irradiation at high doses (20,000 R) causes wrinkling of the cells, due to denaturation and coagulation, subsequent to loss of water. (TCO)

12973 QUANTITATIVE CHANGES IN EXTRACELLULAR WATER IN RADIATION DISEASE. Stanislaw Kosmider and Edmund Rogala (Silesian School of Medicine, Zabrze, Poland). Arch. Immunol. Terapii Doswiadczalnej, 9: 501-7 (1961).

Rabbits were irradiated with 200-kv x ray. The dose rate was 10.6 R/min. In rabbits irradiated with 200 R a decline in body weight on the third day after exposure was observed. Loss of extracellular water was proportionally greater than loss of body weight. Ten days after irradiation extracellular water increased over the levels recorded before the experiment, accompanied by a decline in body weight. On the twentieth day a further slight decline in body weight and extracellular water was observed. Rabbits irradiated with 500 R exhibited changes similar to those in the previous group, but more intensive. The loss of water was greater than in the animals exposed to 200 R. After 10

days all the animals showed decreased body weight, and most of the animals an increase in extracellular water. Twenty days after irradiation a drop in body weight due to loss of extracellular water was observed. From these data it is evident that penetration of extracellular water into the cells, causing their swelling, is an early manifestation of exposure of the living body to x rays. The decline in body weight can be attributed to loss of appetite subsequent to irradiation or to an intestinal syndrome, but none was observed. The marked loss of extracellular water 10 days after exposure to radiation can be expected to lead to morphologic changes in the cells. (BBB)

12974 ON THE EFFECT OF β-RADIATIONS ON THE BINDING OF ^{35}S-SULFATE IN THE CORNEAL TISSUES. W. Muenich (Universität, Würzburg, Ger.). Arch. Ophthalmol., 164: 457-62(1962). (In German)

The right eyes of 32 rabbits were irradiated with a ^{90}Sr applicator. Four groups of 8 animals each were exposed to single doses of 325, 500, 600, and 1000 Rep, respectively. The left eye of each animal served as a control. Eight hr after irradiation the animals were intravenously injected with a ^{35}S-sulfate solution. The eyes were enucleated 80 hr after irradiation, and the ^{35}S was measured in the mucopolysaccharide (ester sulfate) fraction of the corneas. Electrophoresis showed that the largest fraction of the ^{35}S was contained in the mucopolysaccharide fraction. There were no significant differences between the amounts of ^{35}S incorporated into the ester sulfate fraction in the corneas of the animals irradiated with 325 or 500 Rep. The fraction of the dose incorporated was about 70% for each of these groups. After irradiation with 600 Rep the corneas contained an average of 62.2% of the administered dose in the ester sulfate fraction, as compared to 73.9% in the unirradiated corneas. The corneas irradiated with 1000 Rep incorporated only 55.9% of the administered dose of ^{35}S into the ester sulfate fraction, as compared to 75.4% incorporation by the control corneas. These differences were statistically significant. Even though morphological differences were not evident, these results indicate that enzymatic reactions necessary for incorporation of sulfate groups into the mucopolysaccharide fractions of the rabbit cornea may be altered by exposure to radiation dosages as low as 600 Rep. (BBB)

12975 INTACT TUMOR CELLS IN IRRADIATED TISSUE. Herman D. Suit and Harry S. Gallager (Univ. of Texas, Houston). Arch. Pathol., 78: 648-51(Dec. 1964).

For periods up to 110 days after x radiation doses of 6600, 8100, and 9400 Rad to spontaneous mammary carcinomas of the C_3H mouse, small nodules often persisted. These nodules contained tumor cells which were morphologically intact and considered viable. However, no instance of a local recurrence was observed after doses of 8100 to 9400 Rad for observation periods of up to 300 days (radiation having been given under conditions of local tissue anoxia). When the residual nodules were removed 19 to 44 days after treatment, in all instances normally staining and morphologically intact tumor cells were observed. However, on isotransplantation, tumor growth was observed in 10/12 attempts after 4000 Rad, 2/7 attempts after 5760 Rad, and 0/18 attempts after 7600 Rad; the transplanted animals were observed for 150 days. The transplant take rate corresponded closely to the probability of local recurrence if the nodule had not been removed. Thus these results do not offer any indication of a tumor bed effect on the regrowth of an irradiated tumor, nor is there a suggestion that host defenses (immunologic or other) were operating to restrain the proliferation of the observed intact cells in these nodules. These studies show that the persistence of histologically intact cells in irradiated tissues does not indicate the probability of a local growth of the tumor. That is, the only proof that cells in tissue are viable is the demonstration of their ability to produce a local recurrence. (BBB)

12976 ELECTRON MICROSCOPIC FINDINGS IN THE CAPILLARIES OF RABBIT BRAIN AFTER THE ACTION OF IONIZING RADIATIONS. J. Cervos-Navarro (Universitat, Bonn). Arch. Psychiat. Nervenkrankh., 205: 204-22 (Mar. 16, 1964). (In German)

A group of 6 rabbits were irradiated cranially with 1500, 2000, or 2500 R from a telecobalt source. After 6 months, samples of tissue were taken from the parietal regions of three animals, representing each level of irradiation. One yr after the irradiation parietal tissue was removed from the remaining three animals. The initial stages of change that typified the delayed vascular reaction to irradiation were studied. In comparison with unirradiated rabbits the numbers and sizes of vesicular bodies in capillaries of irradiated animals were increased in the cytoplasm of endothelial cells. Also, they were observed in areas of the endothelial cells where they are not found usually. Numerous multivesicular bodies were seen within the endothelial walls of the capillaries. The findings were associated with increased permeability of the capillaries. The basic mechanisms of the primary events induced by the irradiation within a few seconds of exposure are unknown. (80 references). (BBB)

12977 HANGING DROP CULTURE OF FIBROBLASTS IRRADIATED WITH 5000 r X RAYS. Oliviero Mario Olivo and Isabella Galliani (Universita, Bologna). Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat., 36: 25-30 (Jan. 1964). (In Italian)

The effects of a single dose of 5000 R x radiation on the growth of cultures of fibroblasts taken from chicken tendons on the 14th day of incubation were studied systematically. Chronological observations on the lethal effects, mitotic activity, and morphological aspects are reported. (J.S.R.)

12978 FREE AMINO ACIDS IN THE EMBRYOS OF RANA ESCULENTA AND BUFO VULGARIS. QUANTITATIVE DETERMINATION IN NORMAL OVA AND IN OVA FERTILIZED WITH IRRADIATED SPERM. Mario Rattazzi (Universita, Naples). Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat. 36: 75-85(Jan. 1964). (In Italian)

The alterations of protein metabolism in embryos of Rana esculenta and Bufo vulgaris whose development was blocked because of the irradiation of sperm were investigated using the amount of free amino acid as the standard. The sperm were exposed to 1200 R at a dose rate of 200 R/min. Only 10% of the ova developed and these abnormally. In Rana, cysteic acid and threonine were reduced in concentration in comparison with the controls and alanine disappeared. The other amino acids increased in concentration. In Bufo, aspartic acid, thronine, and the glutamic acid + glycine + serine group decreased and alanine disappeared. The numerical data are tabulated and illustrated graphically. (J.S.R.)

12979 UV-INACTIVATION OF PHAGE-DNA IN THE HOST CELL AS A FUNCTION OF THE STAGE OF REPRODUCTION. Wolfgang Eckart (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Ber. Bunsenges. Physik. Chem., 68: 743-7(1964). (In German)

After the adsorption of a phage on the bacterial host phage DNA was injected into the cell. During the following replication of the phage DNA the UV-sensitivity of the system changed continuously, until mature phages were formed. Such changes are reported for native and uv-preirradiated T 1 phages. Conclusions were drawn from these data with respect to in- and reactivation processes. (auth)

12980 ENZYMATIC UTILIZATION AND DEGRADATION OF DNA TREATED WITH MITOMYCIN C OR ULTRAVIOLET LIGHT. W. E. Pricer, Jr. and A. Weissbach (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.). Biochemistry, 4: 200-6(Feb. 1965).

Escherichia coli K12λ DNA, alkylated with mitomycin C in vitro, was found to be utilized one-third to one-fourth as well as native DNA when tested as primer for E. coli DNA or RNA polymerase. The alkylated DNA was also degraded

at a slower rate than native DNA by three distinct exonucleases obtained from E. coli: the λ-exonclease associated with λ-phage formation, the phosphodiesterase (Exo I) which is specific for single-stranded DNA, and the exonuclease associated with DNA polymerase (Exo II). However, the RNA-inhibitable endonuclease, obtained from E. coli, and pancreatic endonuclease attack alkylated DNA at almost the same rate as native DNA. DNA, irradiated with ultraviolet light, acted the same as alkylated DNA with the aforementioned enzymes. (auth)

12981 SEARCH FOR REPAIR OF ULTRAVIOLET DAMAGE IN MUTANTS OF BACTERIOPHAGE T4. W. Sauerbier (Universitat, Cologne). Biochim. Biophys. Acta, 91: 663-5(Dec. 16, 1964).

The fate of thymine dimers was followed after infecting E. coli B with uv irradiated $T4v^+x^+$, $T4v^-x^+$, and $T4v^-x^-$ to determine the mechanisms in uv sensitivities in T4. It was found that thymine dimer was neither monomerized nor excised from the DNA. It was concluded that if thymine dimer really is the major lethal uv photoproduct, the results suggest that repair mechanisms in a strict sense are not involved in determining the uv sensitivity of T4. (P.C.H.)

12982 STUDIES OF THE CAPACITY OF BONE-MARROW CELLS TO RESTORE ERYTHROPOIESIS IN HEAVILY IRRADIATED RATS. N. M. Blackett, P. J. Roylance, and Kay Adams (Royal Cancer Hospital, Belmont, Eng.). Brit. J. Haematol., 10: 453-67(Oct. 1964).

Radioiron was used to measure the extent of the recovery in erythropoiesis in heavily irradiated rats injected with bone-marrow cells. It was shown that the cells in the bone-marrow inoculum that are responsible for this repopulation divide frequently (at least once each day) during the recovery period. These cells have the properties of stem cells since they are capable of providing a continuous supply of mature red cells. However, the term repopulating ability and not stem cells is preferred since in the event of some adaptation by the cells to the new environment of the recipient animals, an overestimate of the stem-cell content of the donor animals is likely. Furthermore this term emphasizes that a particular cell function is being measured and not the numbers of a particular type of cell. The effect of 200-R doses of whole-body x irradiation on the repopulating ability of the bone marrow was studied. A reduction in the reproductive integrity of the repopulating cells to 34% of normal was obtained, a value greater than that obtained for mice by other workers using different experimental techniques. The repopulating ability was shown to decrease from a value of 34% of normal immediately after irradiation to 8% four days after irradiation and then to recover, regaining normal values between 15 and 20 days. The same result was obtained following irradiation of polycythemic rats, in which red-cell production is greatly reduced, so that it is possible to exclude the early recovery in red-cell production as a cause for the fall in repopulating ability during the first four days. Other possible explanations of this fall are discussed. The results show that the eventual repopulation of the entire erythropoietic system after 200-R whole-body irradiation arises from fewer cells than those which have retained their reproductive integrity. Furthermore, for this dose of radiation, recovery in erythropoiesis occurs before the recovery in repopulating ability, suggesting that there is a considerable reserve of cells with this capacity in the bone marrow of normal animals. Alternatively, the reduced repopulating ability may be compensated by greater proliferation of the erythroid precursors. The low repopulating ability of rats subjected to 50 Rad/day continuous γ irradiation supports this suggestion of a reserve of repopulating ability. Bone-marrow differential cell counts after 200-R whole-body irradiation showed that there is no correlation of repopulating ability with the various stages in cell maturation of the erythroid, myeloid, or lymphoid series, except perhaps with the myeloblasts. Marked recovery in small lymphocytes prior to the recovery of repopulating ability excludes these cells as having repopulating ability. (BBB)

12983 THE EFFECTS OF CONTINUOUS IRRADIATION ON CELL PROLIFERATION IN RAT BONE MARROW. B. I. Lord (Royal Cancer Hospital, Belmont, Eng.). Brit. J. Haematol., 10: 496-507(Oct. 1964).

A study was made of the effects of continuous, whole-body γ irradiation on the pattern of cellular proliferation in the bone marrow of the rat, using tritiated thymidine as a DNA marker. The results are considered in terms of the capacity of the marrow to respond to the chronic irradiation stress. First generation, hybrid male rats of the inbred August and Marshall strains were exposed to ^{137}Cs. For autoradiography and total tritium assay, 50 μC of tritiated thymidine was given to each animal either intravenously or intraperitoneally. Two dose rates were used, 84 and 50 Rad/day, for periods of up to 50 and 112 days respectively. On completion of the exposure the animals were removed from the irradiation chamber for the injection of ^3H-thymidine. The erythroid-myeloid ratio, calculated from the differential cell counts, increased throughout the period of exposure. These changes were due to a large decrease in the number of myeloid cells while the erythroid population appeared to suffer relatively small losses. After fat extractions with alcohol-ether, it was expected that the remaining marrow would consist only of cellular material. However, it was shown that while the total number of nucleated cells in the tibia fell to about 20% of the initial value in 50 days at 84 Rad/day, the fat-free fraction fell to only 50% of its initial value. During the first 35 days at 50 Rad/day, the fat content increased but then appeared to decrease again while the cellularity remained well below the corresponding value for non-fatty marrow. The reason for this discrepancy was, in part, due to the changing proportions of the various cell types. Following irradiation, the remaining cells had a greater mean cell size. Measured cell diameters in smear preparations showed that the mean marrow cell volume was about 1.5 times greater than normal in animals irradiated for 133 days at 50 Rad/day. In addition, on irradiation the marrow became more fluid, containing large numbers of mature erythrocytes. In drying and in fat extraction, therefore, a large amount of cellular material from the erythrocytes was left as part of the fat-free dry fraction. With the exception of the grain counts at 50 Rad/day, all the labeling indices and grain counts changed with time in a similar manner. There was an initial increase followed by a plateau level, maintained until death. The overall percentage of the cells labeled was doubled after 15 days at the higher, and after 35 days at the lower dose rate. The life expectancy of hybrid rats was normally at least 50 days after starting the irradiation at 84 Rad/day and 120–150 days at 50 Rad/day. In both cases, the higher level of labeling was maintained until these limits were approached. Then, as the condition of the animal deteriorated, the proportion of cells capable of taking up thymidine decreased. The proportion of lymphocytes, initially about 20% of the total marrow population, fell to about 12% over the first 10 days at 84 Rad/day but then tended to make a slight recovery. The same increase in the labeling index as for the other cell type was apparent. Thus, the response of the bone marrow to continuous irradiation is similar at both 84 and 50 Rad/day though the time scale of the changes differs. Over the initial 15 days at 84 Rad/day and 35 days at the lower dose rate, the labeling indices of all the cell types increased rapidly. After this period, cell proliferation in the bone marrow appears to settle in a new steady state condition which is maintained until death becomes imminent. The increase in labeling index suggests an increase in the mean proliferation rate, that is, a decrease in the mean cell cycle time. (BBB)

12984 THEORETICAL INTRODUCTION TO THE COLLOQUIUM ON THE BIOLOGICAL EFFECTS OF LOW DOSES OF IONIZING RADIATIONS. Walter G. Verly (Universite, Montreal). Bull. Inform. Assoc. Belge Develop. Pacifiques Energie At., 9: No. 51, 3-6(Aug. 1964). (In French)

The basic concepts of biological effects of low radiation doses in human populations are reviewed. Tolerances, the

dose-effect relation, coefficients of relative biological effectiveness, dose fractionation, and external and internal doses are considered. (J.S.R.)

12985 THE ROLE OF EPIDEMIOLOGY IN THE ETIOLOGY OF LEUKEMIA. Robert W. Miller (National Cancer Inst., Bethesda, Md.). CA, Med. J., 14: 130-4 (July-Aug. 1964).

Evidence for the possible role of ionizing radiation in leukemogenesis is reviewed and evaluated. The Japanese survivors of the atomic bomb experienced a rise in leukemia rates which proportionate to the radiation dose received. The peak incidence occurred about six years after the bomb, and thereafter the rates have fallen to near-normal levels. The lowest dose for which an effect was detectable was about 80 rad. Other studies of 1502 children who had received radiation treatment for enlargement of the thymus (up to 27 yr before) revealed six cases of leukemia as compared with 0.6 cases expected on the basis of vital statistics. This difference was highly significant, but repeat studies on the same group have yielded no additional cases, and similar studies by other investigators have not confirmed the excessive occurrence of leukemia among thymus-irradiated children. More convincing evidence that partial-body therapeutic radiation doses may be leukemogenic comes from a study of patients with ankylosing spondylitis treated with x rays. Death was due to leukemia in 28, as compared with an expected 2.9 deaths based on national vital statistics. The casual effect of radiation was further implicated by the finding that there was a dose-response effect, the leukemia mortality rate being a linear function of the radiation dose. Two reports, which suggest that the human fetus may be exceptionally sensitive to the leukemogenic effects of very low doses of x rays, were made of children with leukemia with a history of abnormal exposure to diagnostic radiation during pregnancy. In such investigations it is difficult to exclude the possibility that in early pregnancy some disorder occurred which is primarily related to the childhood cancer and that the diagnostic radiation merely marks the occurrence of the pregnancy disorder. It is suggested that as epidemiologists identify subgroups of people who have an exceptionally high risk of leukemia, opportunities will be provided for intensive studies of the preleukemic phase of the disease. Among the high-risk subgroups already identified are the twin-sibs of leukemic identical twins and patients with radiation-treated polycythemia vera. The proportion of people who develop leukemia in these two groups (10 to 20%) is much higher than that of mongoloids (1 to 2%) or the heavily exposed atomic-bomb survivors (1%). (BBB)

12986 POSTRADIATION SARCOMA ARISING IN GIANT CELL TUMOR OF BONE: REPORT OF A CASE. Chia-Ch'ing Chang, Teh-Ling Chang, and Ch'uan-Han Feng (Peking Medical Coll.). Chinese Med. J., 83: 607-11 (Sept. 1964).

To illustrate the hazards of improper use of radiation therapy on benign tumors or lesions of bone, a case of postradiation sarcoma of bone is reported. After a fall a 33-yr-old man developed a firm tender mass distal to the right olecranon process. Roentgenographic examination showed rarefied areas in the upper third of the right ulna, and a diagnosis of giant cell tumor was made without pathologic comfirmation. Deep x-ray therapy at an air dose of 400 R was given, and the patient was hospitalized for continuation of treatment. After a total dose of 4200 R (air dose) was given within 2 weeks, he experienced subjectively remarkable improvement. Follow-up examination carried out three months to 4½ years afterwards showed the lesion to be in a dormant condition. Serial roentgenograms revealed that the original rarefied areas has been gradually replaced by calcification, resulting in an increased density of the tumor shadow. Seven yr later, pain was suddenly felt again in the region of the original lesion and became worse steadily. Roentgenologic examination revealed no change in the size of the lesion, but a portion of the cortical bone in the posterior part of the tumor appeared perforated. Probable malignant changes of the original lesion were suspected and the patient was submitted to operative treatment. Pathologic study disclosed that the proximal segment of the ulna was occupied by an expansive fusiform mass measuring 10 by 5 by 5 cm. Microscopically, the tumor consisted of spindle cells varying in size, shape and arrangement. Radiation osteitis, characterized by interspersing of aseptic dead bone within practically intact bone, was also present. The irradiated bone marrow showed a picture of myelofibrosis, hyalinization, reduction of the myeloid compartment, and replacement by relatively avascular connective tissue. These findings were consistent with sarcomatous changes arising in a giant cell tumor of bone following irradiation. About one year and eight months after the operation, the patient was readmitted for excision of enlarged lymph nodes in the right axilla. Pathologic sections revealed a metastatic pleomorphic fibrosarcoma identical with the lesion in the ulna. N-Formylsarcolysine was then administered orally, and after a total dose of 4800 mg had been given, all the nodules disappeared. However, five months later pulmonary metastasis was found on x-ray examination and death ensued. A review of previous reports shows that the time lag between institution of radiation therapy and the occurrence of sarcomatous changes varies widely. The latent period of the 53 cases of postradiation sarcoma of bone arising in giant cell tumors collected from available literature ranged from three to 24 years. It is suggested that the malignant change and fatal outcome could probably have been avoided had surgical resection instead of radiation therapy been employed initially. Although the x-ray dosage amounted to 4200 R, the tumor tissue was shown to be not completely destroyed. This supports earlier arguments that giant cell tumor is not radiosensitive. (BBB)

12987 OBSERVATIONS ON THE RADIOSENSITIVITY OF OSTEOGENIC SARCOMA. P. H. Emmrich (Humboldt Universitat, Berlin). Chirurg, 35: 73-6(Feb. 1964). (In German)

The effects of radiation on two osteogenic osteoplastic sarcomas of the pelvis and tibia are reported. Growth of the tumors was exceptionally rapid, although this type of tumor and its metastases usually grow rather slowly. The tumors were irradiated with a telecobalt unit. The pelvic tumor received 5400 to 5700 R externally, with a tumor dose of 4000 R. The tumor located in the tibia of the second patient was irradiated alternately in two opposite fields with a series of 20 external doses of 300 R each, where the single tumor dose was 205 R. The total tumor dose was 4100 R. A hemipelvectomy and amputation of the femur were performed to remove the tumors. Preirradiation with conventional or high-energy radiation produces enough damage to radioresistant bone tumors to prevent or restrict metastatic spread when surgical procedures to remove them are carried out. Although the tumor may recur later in another histological form, this observation is not an argument against the value of preirradiation before surgery to prevent metastases of bone tumors. (BBB)

12988 INCREASE OF ANTIBODY RATE FOLLOWING ADMINISTRATION OF A VERY WEAK DOSE OF X RAYS. Jean Loiseleur and Michelle Petit (Institut Pasteur, Paris). Compt. Rend., 259: 4411-13(Dec. 9, 1964). (In French)

The administration of a very weak dose of x rays during the preparation of an animal by injections of an antigen caused a considerable increase of the antibody formation rate. (tr-auth)

12989 EFFECT OF X RAYS ON THE SEROTONIN CONTENT IN THE BLOOD OF THE RABBIT. W. Nakamura, K. Shibata, H. Momma, and H. Eto (National Inst. of Radiological Sciences, Chiba, Japan). Compt. Rend. Soc. Biol., 158: 1426-9(1964). (In French)

The change in the serotonin content of the blood after a whole-body irradiation of 250, 500, or 1000 R was studied in male rabbits. The serotonin content was lowered near the 12th hour after irradiation with 500 R. Elevation of the serotonin level did not occur during the 24 hrs after irradiation with 500 and 1000 R even with successive blood

samplings of 1 ml every 4 hrs. On the contrary, x rays at 1000 R lower the level of serotonin in blood. (J.S.R.)

12990 LIGHT DERMATOSES WITHOUT ABNORMAL REACTIONS TO SINGLE TEST IRRADIATIONS. P. B. Rottier (Rijksuniversiteit, Utrecht). Dermatologica, 129: 286-91(1964).

Three cases of dermatoses caused by exposure to light are discussed in which, contrary to expectation, no abnormal response to single test irradiations could be observed. In two of these repeated irradiations with heavy doses of glass-filtered mercury-arc light, so called white light, produced a papular reaction. Though such cases are rather insensitive to light, they may however acquire their eruption even by exposure to sun- and daylight through window glass. (BBB)

12991 FUNCTIONAL CHARACTERISTICS OF BURN SHOCK COMBINED WITH RADIOACTIVE LESIONS. B. A. Suvorov, B. A. Sakov, D. I. Kolotienko, and L. G. Alenina (Rostov Medical Inst., USSR). Eksperim. Khirurg. i Anesteziol., 8: 10-12(July-Aug. 1963). (In Russian)

Studies were conducted in dogs on changes in functional condition of the dura mater, and neural elements immediately adjacent to it, and changes in the condition of autonomic nervous system after combined burn shock and radiation injury. In the nonirradiated (control) group of ten animals, burns were made with burning cotton applied for three min on the lower abdominal wall and inner hip surfaces. Burn trauma was accomplished in all cases, an edematous phase of which never reached a stage of prostration. The second group of 14 dogs received 500 to 600 R followed by infliction of burns one to one-and-one-half hr after irradiation. Electroencephalograms (EEG) showed that bioelectrical activity of the entire surface of the dura mater was increased; sharper reactions to noise and light stimuli were noted, suggesting increased electrophysiological excitability of the dura mater. Voltage potential increased three to four times in irradiated-burned dogs as compared to one-and-one-half to two times among the burned controls. In four dogs a similar type of burn trauma was induced on the seventh day after irradiation (500 to 600 R). Amplitude of EEG waves greatly exceeded those of the control tracings. Reaction to noise gradually increasing in intensity was absent except for occasional paradoxical responses. An immediate decrease of EEG potential followed burn trauma, while reaction to pressure was negligible and hearing was usually impaired. Excitability of the sympathetic nervous system increased in most cases, but that of the parasympathetic nervous system remained the same or decreased slightly after irradiation. Blood parameters were only slightly affected, hemoglobin and erythrocytes increasing, and the developing leukopenia being accompanied by the characteristic lymphopenia. In irradiated dogs, blood pressure dropped immediately after burn trauma; the nervous activity controlling blood flow decreased. Of the 14 dogs, four died immediately or within ten min after sustaining burn trauma; in six cases arterial pressure remained constant until death occurred within 20 to 25 min from heart failure; in four dogs arterial pressure fell slowly, death occurring within one hr after burn trauma. It is concluded that irradiation augments the severity and rapidity of development of shock in the traumatized animal. (BBB)

12992 THEORETICAL STUDIES ON THE METHODOLOGICAL PROCEDURES OF RADIATION BREEDING. I. NEW METHODS IN AUTOGAMOUS PLANTS FOLLOWING SEED IRRADIATION. Yoshio Yoshida (National Inst. of Agricultural Sciences, Hiratsuka, Japan). Euphytica, 11: 95-111(1962).

Beneficial or desired mutants can be induced in plants by radiation, a desirable mutant being defined here as one having an additional desirable morphologic or physiologic character which is not found in its mother variety and which gives the mutant in later generations, such as X_5, a yield similar to, slightly superior to or slightly inferior to the original variety. The question of the effectiveness of radiation breeding as compared with conventional breeding methods has not been resolved; consequently, it is important to investigate methods to increase the efficiency of radiation breeding. This may be accomplished in the following three ways: control of the mutation process, increase of the mutation rate, and more efficient recovery of mutants. The present studies were intended to establish more effective methods of screening desirable mutants from irradiated populations when the introduction of an additional desirable character such as short culm or early maturity is desired. After seed irradiation, the first screening is ordinarily performed on a large scale in X_2 generation. This study criticizes the conventional ear-to-row method and establishes methods for the recovery of one or more desirable mutants in X_2 from a smaller total number of X_2-plants, and of X_1- and X_2-plants in the aggregate which will economize on both labor and land. The relative efficiencies of four new methods and the standard method are compared, the improved ear-to-row method (method B), the one-plant-one-grain method (method C), the one-plant-two-grain method (method D), and one-plant-three-grain method (method E) all of which are more effective than the conventional ear-to-row method (method A). In method B, the total number of X_2 plants required to recover at least one desirable X_2 plant is obtained when the probability of detecting at least one X_2 line with one or more desirable mutants among X_2 lines is equal to the probability of detecting at least one desirable mutant among plants in that X_2 line. In methods C, D, and E, one, two, or three grains respectively, taken from each of the X_1 plants of the number required to detect at least one desirable X_2 plant, are sown to obtain corresponding X_2 plants. The number of X_1 plants, total X_2 plants, and X_1 and X_2 plants in the aggregate required to obtain at least one desirable mutant (m, mn and m + mn respectively) shows the following relations: method $C > D > A > E > B$ for m, $A \gg B \gg E > D > C$ for mn, and $A \gg B \gg C > D > E$ (the last two being very close to each other) for m + mn. Each of the new methods B, C, D, and E are applicable in radiation breeding. When the discrimination of a mutant is difficult, method B will be useful. On the contrary, when a mutant is easily distinguishable, method C, with dense planting in X_1, will frequently be much better. In some cases methods D and E, especially D, will be more useful in the practice of radiation breeding than method C. Method A should not be used in any case. (BBB)

12993 FACTORS INFLUENCING NUCLEAR DAMAGE IN RAT THYMOCYTES IRRADIATED WITH 30 KR OF X-RAYS. J. F. Whitfield and H. Brohee (C.C.R.-EURATOM, Ispra, Italy). Exptl. Cell Res., 36: 676-9(Dec. 1964).

The rate of appearance of nuclear damage in rat thymocytes irradiated with 30 kr was unexpectedly slow in a medium containing 15 mM phosphate. However, increasing the phosphate concentration to 30 mM doubled the rate of development of pycnosis. The results were obtained using preparations made with cells mixed with serum prior to fixation. When serum was not used the cells with damaged nuclei were largely destroyed by the cytological manipulations and the observed rate of development of nuclear damage was much lower. (auth)

12994 EFFECT OF X-RAY IRRADIATION ON THE STRUCTURE OF DNA MOLECULES IN SOLUTIONS. V. A. Zhidkov and G. M. Rekun (Bogomoletz Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 10: 661-2(1964). (In Russian)

Investigations were conducted on solutions of DNA isolated from the thyroid of a calf, from duck erythrocytes, and from the mucosa of rabbit intestine. Structural-mechanical properties of irradiated DNA solutions, such as viscosity and change in pressure of saturated water vapor over the solutions at 50°C were studied. A decrease in the specific viscosity of DNA solutions in concentrations of 0.01–0.025 percent under the effect of doses of 600 R and over was established, which is explained as a result of destruction of DNA molecules; solutions of concentration of 0.1–0.3 percent irradiation lead to an increase in viscosity. The

pressure of saturated water vapor over 0.18 percent solutions rose as a result of irradiation, which indicates increase in the free energy. The results are explained by the formation under the effect of irradiation (in concentrated DNA solutions) of intermolecular bonds. The change in viscosity of DNA solutions from various species of animals displayed specific features to the action of x irradiation. Spectrophotometric investigations of nitrogenous bases showed that thymine and guanine are most sensitive to radiation at doses of 3000 R. (auth)

12995 LONG-TERM OBSERVATIONS OF THE COURSE OF OSTEORADIONECROSIS OF THE CRANIAL VAULT. E. Fischer (Universitat, Tubingen, Ger.). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 99: 831-5 (Dec. 1963). (In German)

Two cases of osteoradionecrosis of the cranial vault resulting from previous irradiation of the hypophysis for acromegaly are described. The first case was a 46-yr-old man who had received a series of irradiations with 165-kv x ray commencing 9 yr before. The left temporal field had been irradiated with ~ 4800 R surface dose (7700 Rad), the right temporal field received ~ 3600 R (5700 Rad), and the parietal region was exposed to ~ 5200 R (8300 Rad). Seven yr later two round osteolytic foci in the parietotemporal area appeared, along with sclerosis of the diploe at the parietal peak, at the juncture of the coronal suture. The osteolytic areas increased in magnitude over the 2 yr that the patient was observed. The second case was a 51-yr-old woman, who was irradiated in 1944 with 3000 R of 185-kv x ray to the right and left temporal areas, the parietal area, and the occipital area, respectively. The cheek and nose areas each received 1200 R. In the same year small irregularly shaped osteolytic areas were observed in the lower rear parietal area. Within 5 yr these had almost doubled in size and extended in a forward direction. Osteolytic foci also appeared in the region of the lambda suture. In 1961 the patient was irradiated again for insufficiency of the anterior lobe of the hypophysis. By this time the osteolytic areas had become very extensive, and there was evidence of brain damage. The total surface dose by this time amounted to 4600 R parietal, 4900 R temporal, and 4550 R occipital. The parietal absorbed dose was 7390 Rad, the temporal dose was 7840 Rad, and the occipital dose was 7280 Rad. (BBB)

12996 GENETIC STUDIES ON RADIORESISTANT AND CHEMICALLY RESISTANT CELLS DERIVED FROM THE MOUSE STRAIN L CELLS IN CELL CULTURE. Masakatsu Horikawa (Kyoto Univ.). Gamma Field Symp., No. 2, 39-49 (Sept. 1963).

A cell line, Lγ resistant to ionizing radiation, was isolated from the original mouse strain L cells. The genetic properties of these resistant cells and other variants (LMit, L8-AZ and LUV cells), derived from the same original L cells, were determined. Lγ cells did not demonstrate the high degree of resistance to radiation expected from variants resistant to other chemical and physical agents. Also, the cross-resistance phenomenon was found in LMit and LUV cells, whereas it was not found among other variants. This suggests that the effects of mitomycin C are comparable to those of uv radiation. It was also found that original L or L8-AZ cells underwent a 20-fold, LUV cells a 12-fold, LMit cells a 5-fold, and Lγ cells a 3-fold increase in number during a 7 day period of incubation. The cell dimensions and morphology also differed among the various resistant cells i.e., large for L and L8-AZ cells, but small for LUV, LMit, and Lγ cells. The original L and LUV cells most frequently had a chromosome number of 63, whereas L8-AZ cells had 68 chromosomes, and LMit cells had 63 chromosomes including 2~3 very small chromosomes. On the other hand, the number of chromosomes in cells resistant to γ irradiation seemed to decrease gradually with repeated irradiation. Lγ cells exposed to total doses of 14000 R had 44 chromosomes. This suggests that the effects of uv radiation may differ somewhat from those of ionizing radiation. (NSA of Japan)

12997 STUDIES ON SERIAL CELL-FREE TRANSMISSION OF RADIATION-INDUCED RF MOUSE LEUKEMIA. Shozo Irino (Okayama Univ., Japan) and Susumu Sota. Gan no Rinsho, 9: 578-84 (Oct. 1963). (In Japanese)

The authors previously reported on cell-free transmission of radiation-induced RF mouse leukemia to newborn mice of the same strain. This report describes similar studies in which the disease was transmitted to mice from a different strain. Mice 30 to 40 days old were irradiated with a 200 KVP, 15 ma x-ray beam through a 3-mm aluminum plate at distance of 84 cm at dose rate of 33.5 R/min. Incidence of leukemia was 44.4% at dose of 250 R, 77.3% at 350 R, and 35.2% at 450 R. Incidence at the highest dose rose to 52.9% after two years. Comparisons are made of mice inoculated with naturally occurring and radiation-induced leukemia respectively. Diseased mice were dissected, analyzed, and studied for the various conditions associated with leukemia. Transmission of both lymphatic and bone-marrow leukemia induced by radiation are described. (TTT)

12998 ARE INDUCED MUTATIONS IN DROSOPHILA OVERDOMINANT? I. EXPERIMENTAL DESIGN. H. J. Muller and Raphael Falk (Indiana Univ., Bloomington). Genetics, 46: 727-35 (July 1961).

The background of the problem of overdominance and the plan of experiments to test for overdominance of induced mutations are presented. The third chromosome was investigated by allowing a wild-type third chromosome, the prototype, to cross over, through one or two generations, with a third chromosome provided with suitably spaced markers. A single final recombinant, called the marked chromosome, was chosen. After the establishment of the two stocks having their third chromosomes coisogenic except for the specially marked region, some flies containing the prototype chromosomes were irradiated. A series of lines of descent were established by crossing between these flies and flies homozygous for the marked unirradiated third chromosome. In any given line all the males chosen for breeding were always heterozygous for a given prototype third chromosome ultimately derived from a single irradiated germ cell or from a parallel unirradiated germ cell of a control fly of the same generation, as well as for a marked third chromosome derived from their mother. This experiment allowed a much more direct comparison between the viability effects of irradiated and unirradiated chromosomes than in previously reported work, since this comparison can be made between flies of the same culture. These techniques were used to investigate whether induced mutations when in heterozygous condition and unselected can increase the average viability of an otherwise homozygous genotype. Their design afforded every chance for an induced increase in viability to be detected. (BBB)

12999 ARE INDUCED MUTATIONS IN DROSOPHILA OVERDOMINANT? II. EXPERIMENTAL RESULTS. Raphael Falk (Indiana Univ., Bloomington). Genetics, 46: 737-61 (July 1961).

More than 60 lines of Drosophila were prepared, each having an irradiated third chromosome marked with the gene ve, carried along with a ve st marked chromosome (coisogenic — except for the st locus and its vicinity — with the ve-marked chromosome before its irradiation), and homozygous as well as isogenic with respect to the second chromosome genes. Males were repeatedly outcrossed to females from a stock homozygous for second and third chromosomes which were also coisogenic with the unmarked second and the ve st third chromosomes of the treated and control lines. Six doses of 4000 R each were given to males at five-day intervals. The irradiated males were kept for 15 days after the last irradiation before deriving from them the offspring studied, so that practically only sperm that had been irradiated at spermatogonial stages was utilized. In each line the viability of the ve flies heterozygous for induced mutations, or the viability of the corresponding controls, was determined from the proportion of ve females or males out of the total

of the respective ve and ve st phenotypes, the latter serving as a reference group for determining the viability of the former. In nearly every possible comparison the treated lines had a lower mean viability than the untreated lines. The reduction of viability caused by the presence in heterozygous condition of radiation-induced mutations ranged from zero to three %. The reduction in viability was more pronounced in earlier counts than in later ones of the same crosses indicating that not only viability but also rate of development was adversely affected by the irradiation. The reduction of viability found among heterozygotes for nonlethal-bearing chromosomes was about the same in extent as that expected for the lethal-bearing heterozygotes. In the homozygotes, on the other hand, 90% of the reduction of viability was due to lethals and only about ten % to nonlethal detrimentals. This result supports the notion that nonlethal deleterious mutants are on the average relatively more dominant than lethals. (BBB)

13000 THE REACTION OF THE SYMPATHICOADRENAL SYSTEM IN PREVENTIVE ULTRAVIOLET IRRADIATION. M. S. Koshkin, A. G. Idlina, O. V. Anisimova, and A. A. Filatova (Khar'kov Medical Inst.). Gigiena i Sanit., No. 11, 13-18(Nov. 1964). (In Russian)

Adrenalin and noradrenalin levels in the urine of children exposed to prophylactic ultraviolet irradiation to compensate for insufficient sunlight were investigated to determine the reaction of the sympathetic adrenalin system. The subjects were exposed first to $\frac{1}{10}$ biodose with gradual increases to $\frac{1}{2}$ biodose given 3 times a week. Adrenalin and noradrenalin levels of the urine were determined by a fluorescent method. The phagocytic index determined in a staphylococcus culture was used to assess the general reaction of the sympathetic adrenalin system. Findings show that prophylactic ultraviolet irradiation increases the noradrenalin level, and to a lesser degree, the adrenalin level. The phagocytic index also increases significantly. Increased catecholamine levels in the urine accompanied by increased phagocytic activity improved the general condition of all children exposed to ultraviolet irradiation. Ultraviolet irradiation may be regarded as an actuating mechanism which sets the sympathetic adrenalin system into action and thereby stimulates the vital functions of the organism. (TCO)

13001 THE IMMUNE RESPONSE TO AZO-PROTEIN CONJUGATES IN RABBITS UNRESPONSIVE TO THE PROTEIN CARRIERS. D. Nachtigal and M. Feldman (Weizmann Inst. of Science, Rehovoth, Israel). Immunology, 7: 616-25 (Nov. 1964).

Rabbits, made unresponsive to human serum albumin by means of antigen injections following total-body x irradiation, were immunized with sulfanil-azo conjugates of human serum albumin (HSA). Non-treated rabbits were similarly immunized with sulfanil-azo conjugates of rabbit serum albumin (RSA). Both groups reacted to the sulfanil-azo determinant, forming two types of antibodies. One cross-reacted with sulfanil-azo proteins of the homologous and two heterologous carriers; the other was specific to the conjugate of the homologous protein, although the animals were unresponsive to the homologous protein in its native state. In this respect, namely the immunologic response to azo-protein conjugates, animals which are naturally tolerant to the protein carrier, and animals which were made tolerant to the protein carrier, are basically similar. The formation of antibodies specific to the homologous conjugates indicates that the hapten conjugation resulted in the formation of an antigenic determinant comprising both the haptenic group and part of the protein carrier. Upon further immunization with the hapten-protein conjugates, in rabbits tolerant to HSA, the tolerance to the protein carrier was abolished. Rabbits made unresponsive to HSA by x-ray treatment were immunized with the RSA conjugate. A good response to the azo-RSA was found, while no binding antibodies to HSA were present. These findings imply that the steric changes in RSA, concomitant with diazo coupling, opened up antigenic determinants either identical or overlapping with some of those present on the HSA molecule. The converse situation did not occur: diazo coupling of HSA did not disclose the emergence of determinants cross-reacting with RSA. (BBB)

13002 SURVIVAL PROPERTIES AND REPAIR OF RADIATION DAMAGE IN L-CELLS AFTER X-IRRADIATION. Antun Han, Branimir Miletic, Danilo Petrovic, and Dinko Jovic (Institute "Ruder Boskovic," Zagreb). Intern. J. Radiation Biol., 8: 201-11(1964).

Using an established line of L-cells and 230 kv x rays, the survival properties and recovery after irradiation were studied. Results of experiments seem to be in agreement with those published for Chinese hamster and HeLa cells. L-cells are capable of recovery after x irradiation. The processes responsible for recovery start promptly after irradiation. The progeny of surviving cells, i.e. sublethally-damaged cells, display complete recovery some time after the first exposure of 375 R (10 per cent surviving cells). The results are compared to those described by Elkind and Lockart for Chinese hamster and HeLa cells. (auth)

13003 OSMOTIC PROCESSES IN THE CELL AFTER ULTRA-VIOLET IRRADIATION. Ferdinand Hercik (Inst. of Biophysics, Brno). Intern. J. Radiation Biol., 8: 213-21 (1964).

Ultraviolet rays caused closing of stomata in cuts of Begonia semperflorens leaves. The doses necessary for stomata closing approach, in respect of order, those necessary for inactivation of bacteria. Stomata closing cannot be photo-reactivated. Radiation at wavelengths of 2537 Å and 2804 Å proved most effective. A relationship between dose-effect and the time course of reaction was found. A definite interpretation of this phenomenon will not be possible until the similar effect of ionizing radiation has been evaluated. Polonium alpha-rays, cobalt gamma-rays, and 50 kv x-rays cause quick stomata closing in Begonia. (auth)

13004 ANTI-BACTERIAL ACTION OF IRRADIATED GLUCOSE. N. Molin and L. Ehrenbert (Svenska Institutet for Konserveringsforskning, Goteborg). Intern. J. Radiation Biol., 8: 223-31(1964).

It is shown that γ-irradiated glucose has a strong, anti-bacterial action on Pseudomonas sp. 128. Irradiation of the water solution of glucose is more effective than irradiation of modifications of crystalline glucose. Part of the anti-bacterial effect remains after storage of the irradiated solution for six days at 20°C. After treatment with irradiated glucose the surviving bacteria are found to be more resistant to a repeated treatment. The bactericidal action of irradiated glucose increases with decreasing pH of the test solution, and was abolished by added catalase. The possible nature of the anti-bacterial factor(s) in irradiated glucose is discussed. (auth)

13005 PRELIMINARY DATA ON THE RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) OF THE 1000 Mev GAMMA-RADIATION DELIVERED BY THE FRASCATI ELECTRON-SYNCHROTRON. T. Alescio, C. Biagini, E. Borghese, M. Di Paola, and M. Ladu (C.N.E.N., Frascati, Italy and Universita, Rome). Intern. J. Radiation Biol., 8: 233-7(1964).

The authors submitted adult male mice to the gamma-beam of the Frascati electron-synchrotron and studied survival up to 30 days. For comparison, other mice of the same strains were irradiated with x rays. Preliminary data on the LD_{50} were obtained and appeared to be around 730 rads for x rays and around 840 for the synchrotron beam: the relative biological effectiveness of the latter as against x rays would therefore be of the order of 0.87. This value does not significantly differ from that obtained for high-energy beams of 2 to 3 Mev. (auth)

13006 THE EFFECT OF VERY LARGE DOSES OF RADIATION ON THE THYMUS CORTEX. O. A. Trowell (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 8: 239-61(1964).

In the thymus cortex of young rats acutely exposed to 13 kr or more of x radiation, autolytic breakdown of the radiation-killed lymphocytes was considerably delayed, and the reticulum cells died after three to four days. The same occurred when organ cultures of normal thymus were irradiated in vitro, and the delayed autolysis was equally evident when thymus-lymphocyte suspensions were irradiated. No such phenomena were seen in the thymus medulla or in lymph nodes, in vivo or in vitro. In thymus cultures, the autolysis of cortical lymphocytes killed by chemical poisoning was not delayed by pre-exposure to 40 kR. It was concluded that very large doses of radiation act directly on these cells, inhibiting some pre-autolytic event in the process of post-irradiation cytolysis, and that this event is specific both for radiation and for thymus cortical lymphocytes. (auth)

13007 EXCRETION OF BETA-AMINO-ISOBUTYRIC ACID AS AN INDEX OF RADIATION EXPOSURE. Hylton Smith, T. H. Bates, and Christine I. Smith (United Kingdom Atomic Energy Authority, Annon, Dumfriesshire, Scotland). Intern. J. Radiation Biol., 8: 263-70(1964).

A study of the urinary-excretion pattern of BAIBA in 25 patients receiving radiation therapy indicated that BAIBA-excretion is not a reliable index of radiation exposure. (auth)

13008 THE SYNTHESIS OF RNA IN GROWING E. COLI B AFTER IRRADIATION WITH X-RAYS. Olaf Klamerth (Institut fur Virusforschung, Heidelberg). Intern. J. Radiation Biol., 8: 291-6(1964).

Results are reported from a study of the effects of 10,000 R γ radiation on the synthesis of RNA in multiplying cells of Escherichia coli B, as measured by the degree of incorporation of ^{14}C-adenine into single fractions that were separated by chromatography. The irradiated sample was found to have a higher incorporation rate than that of controls. (C.H.)

13009 AUREOBASIDIUM PULLULANS (DE BY.) ARNAUD—A COMMON AND VERY RADIO-RESISTANT FUNGUS ON FRESH FRUITS AND VEGETABLES. J. P. Skou (Atomenergikomissionen, Riso, Denmark). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138, 63-70(1964).

Aureobasidium pullulans (synonyms Pullularia pullulans and Dematium pullulans), or black yeast, is a common fungus in nearly all parts of the world. It is found within and on plants and animals as well as in the air above land and sea areas. It grows well on wounded soft fruits and may be weakly parasitic. A. pullulans was found on nearly all kinds of fresh fruits and vegetables examined. On normal plant material it has little significance. When fresh fruits and vegetables are irradiated, the importance of spoilage due to A. pullulans increases with increasing doses. One reason for the high radioresistance of A. pullulans is related to its polymorphism. In its older stages it produces a large quantity of very radioresistant chlamydospores and resting mycelium. Decimation required 500 krad γ radiation in the case of the chlamydospores and 450 krad for the older blastospores. This proves A. pullulans to be among the most radioresistant organisms known. Starved blastospores from an 18-hr-old culture were considerably more resistant than the chlamydospores and the older blastospores, which may be developing into chlamydospores. Thus resistance in these cells seems to be caused by factors other than starvation. The dose-survival curve for the young starved blastospores shows a distinct bend at 25 krad, indicating that two fractions were present in the culture. They were a relatively sensitive fraction following the form of a single-hit curve, and a very radioresistant fraction following the formula for a multi-hit curve. This phenomenon is explained by the fact that a relatively large fraction of the young blastospores have one or two buds (in rare cases more) and so are more resistant than the single cells. If a method of controlling this fungus cannot be found, it may prove to be one of the most serious limiting factors for the radiopasteurization of fresh fruits and vegetables. (BBB)

13010 THE SYNERGISM OF X-IRRADIATION AND CHOLESTEROL-FAT FEEDING ON THE DEVELOPMENT OF CORONARY ARTERY LESIONS. G. D. Amromin, H. L. Gildenhorn, R. D. Solomon, B. B. Nadkarni, and M. L. Jacobs (City of Hope Medical Center, Duarte, Calif.). J. Atherosclerosis Res., 4: 325-34(July-Aug. 1964).

Studies were designed to determine the role of x-ray therapy in the deaths of several elderly patients when recent myocardial infarctions were found at autopsy. All had recently completed courses of irradiation to mediastinal tumors. The study was devised to reproduce, as closely as possible, the clinical situation and to see if coronary arteries are affected under such circumstances. Rabbits were fed a high cholesterol diet for a sufficient time to develop aortic lesions before x irradiation was begun (500 Rad/week for five weeks, or a total of 2500 Rad). High-cholesterol diet produced xanthomatoses limited to the origins of the major coronary arteries and intramyocardial branches of rabbits. Fractionated x ray to the hearts of otherwise normal rabbits in the amounts and intervals employed was apparently responsible for rare areas of medial degeneration and intimal proliferation of major epicardial arteries. Exposure of hearts of rabbits on high-cholesterol diets to fractionated doses of x ray produced diffuse severe arteriosclerotic and atherosclerotic lesions of major epicardial coronary arteries. Synergism between a physical agent (x ray) and a chemical substance (cholesterol) were apparently necessary to evoke this effect. Deposition of lipid portions of vessels damaged by x irradiation was probably one of the prime mechanisms in the genesis of these lesions. It was concluded that in an elderly patient in whom frank or incipient vessel damage is already present, the tissue damaging effect of x-irradiation may accelerate the development of the coronary arteriosclerosis. (TCO)

13011 EFFECT OF GAMMA RAYS ON IMMATURE STAGES OF THE MEXICAN FRUIT FLY. C. A. Benschoter and J. Telich C. (Dept. of Agriculture, Brownsville, Tex.). J. Econ. Entomol., 57: 690-1(Oct. 1964).

Previous studies have shown the feasibility of using radiation as a quarantine treatment for insect-infested products. They indicated that relatively small dosages of γ rays applied to eggs and larvae of the oriental fruit fly Dacus dorsalis will prevent development beyond the pupal stage. The plausibility of using radiation in quarantine treatment was strengthened by results of dosage-mortality studies conducted to determine the effectiveness of γ rays in preventing development of immature stages of the Mexican fruit fly Anastrepha ludens. At doses of 250 to 2000 R eggs about 1 day old were γ irradiated (^{60}Co) and held in covered petri dishes at 77°F until hatch counts were made 7 days later. Mature larvae also were irradiated at similar doses, allowed to pupate, and mortality was based on the number of adult flies that later emerged. In addition, pupae 5 to 7 days old were exposed to radiation doses up to 25,000 R. A γ-ray dose of 50,000 R administered to 1-day-old flies (requiring nearly 6-hr exposure time) was only 50% lethal to both sexes over a 3-week period, indicating that adults were much more difficult to kill than the other stages. The order of susceptibility is larva > egg > pupa > adult. X rays were equally lethal to this fly and followed the same order of susceptibility of the life stages. Dosages used in this study approximated the amounts of radiation needed to prevent subsequent development of each stage. For example, 50,000 R killed only 50% of the adult flies exposed, but adult flies surviving irradiation as eggs and larvae in mangoes were sterilized by a dose of only 1000 R. This suggested that commodities may be rendered safe from the quarantine standpoint by relatively small amounts of irradiation without concern for killing the insects outright. In this way a quarantine treatment schedule might be based on the minimum γ-ray dose which would prevent normal development of the particular insect stage or stages involved. (BBB)

13012 THE DIFFERING SURVIVAL OF NORMAL AND SENSITIZED SPLEEN CELLS TRANSFERRED TO ALLO-

GENIC HOSTS. Brack G. Hattler, Jr., Michael Schlesinger, and D. Bernard Amos (Duke Univ., Durham, N. C.). J. Exptl. Med., 120: 783-93(Nov. 1, 1964).

It is known that lymphoid or spleen cells from different strains of mice react differently, especially when injected into a hybrid host. To investigate the disposition of transferred lymphoid cells the fates of a normal and specifically sensitized C57Bl and C_3H spleen cells were compared in normal and x-irradiated allogenic hosts, and the respective roles of host and donor cells in the accelerated destruction of sensitized cells were analyzed. It was found that spleen cells sensitized against their prospective recipients could be identified in the host's spleen for 1 day, whereas normal donor cells survived 2 to 3 days. Spleen cells presensitized with an indifferent antigen had survival times similar to normal donor cells. Irradiation (900 R) of the recipients prior to cell transfer eliminated any difference in survival times between normal and presensitized donor cells in allogenic hosts. It is concluded that the host plays an important role in the rapid destruction of spleen cells presensitized against host antigens. Experiments in which sensitized and normal C57Bl spleen cells were mixed and transferred into normal C_3H mice indicated that as little as 5 to 10% of the donor cell population need be sensitized for the entire mixture to behave as if it were obtained from a sensitized animal, as shown by its elimination in the 1-day interval. Concomitant with rapid disappearance of the sensitized spleen cells was a marked increase in spleen weight. The splenomegaly after injection of immune cells was considerably greater than that found after injecting normal cells. This suggests that sensitized cells may constitute a greater antigenic stimulus than non-sensitized cells. Preliminary studies indicate that spleen cells from a previously immunized host are more antigenic than cells from an unsensitized animal regarding both their capacity to absorb antibody and their ability to elicit early antibody formation. (BBB)

13013 THE RESPONSE OF X-IRRADIATED LIMBS OF ADULT URODELES TO NORMAL TISSUE GRAFTS. III. COMPARATIVE EFFECTS OF AUTOGRAFTS OF COMPLETE FOREARM REGENERATES AND LONGITUDINAL HALF FOREARM REGENERATES. Benjamin D. Stinson (Cornell Univ., New York). J. Exptl. Zool., 156: 1-18(June 1964).

An attempt was made to reassess the possible differences in morphogenetic capacity of regenerates elicited from irradiated limbs in response to complete forearm autografts as opposed to longitudinal half forearm grafts under more rigorous experimental conditions. Both forelimbs of adult newts (Triturus viridescens) were amputated through the distal humerus; left forelimbs were subjected to 4000 R localized x irradiation 56 days after amputation. Ten days later surgical procedures were performed in order to test the effects of the following on irradiated upper arms: (a) irradiated complete forearm regenerate autografts, (b) unirradiated complete forearm regenerate autografts, and (c) unirradiated anterior half forearm regenerate autografts. Right unirradiated forelimb regenerates served as the source of normal autografts transplanted into irradiated left upper arms after amputation at the elbow and ablation of the distal humerus of the latter. Grafts were implanted into irradiated stumps with normal proximodistal and dorsoventral polarities, but the anteroposterior axes of grafts were uniformly reversed with respect to those of recipient irradiated stumps. Irradiated stumps were reamputated through the distal portions of the grafts three weeks after implantation; by this time most of the grafts had been revascularized and retained the original orientation relative to the irradiated stumps. Gross observations for 70 days revealed that unirradiated right limbs, subjected to various control operations, regenerated normally in all three groups. Irradiated left limbs into which irradiated complete forearm regenerate autografts had been implanted failed to regenerate in 100% of cases. In contrast, irradiated left limbs into which normal autografts had been implanted regenerated with high frequency. Complete forearm regenerate autografts elicited regenerates which formed complete hands in the best cases, whereas comparable autografts of anterior halves of forearm regenerates elicited only half-hand regenerates with a maximum of two digits. Regenerates thus elicited on irradiated upper arms manifested a normal or only slightly retarded rate of regeneration, reproduced the asymmetry of the normal graft rather than that of the irradiated stump, and formed only structures distal to the level of amputation through the normal graft. Whole mount preparations of limbs fixed on the 70th day and stained to demonstrate cartilaginous skeleton showed that complete hand regenerates formed on irradiated upper arms after implantation of complete forearm grafts and contained complete forearm skeletons within the stumps. In contrast, the half-hand regenerates formed after implantation of anterior half forearm grafts contained only one long bone within the irradiated stumps. The findings are consistent with the hypothesis that normal grafts elicit regenerates on irradiated limbs by providing a source of normal blastema cells and by controlling their morphogenetic behavior and histogenetic fate. (BBB)

13014 INTERRUPTION OF MACROGLOBULIN SYNTHESIS IN MICE BY EXPOSURE TO X-RAYS. Byron S. Berlin (Univ. of Michigan, Ann Arbor). J. Immunol., 93: 315-18(Aug. 1964).

Mice were exposed to x rays after a primary vaccination with killed influenza virus vaccine to examine the influence of ionizing radiation on the synthesis of macroglobulin antibodies. Males of the CF-1 strain were exposed to 500 R whole-body x irradiation three days after a single intraperitoneal injection of formalin-treated influenza virus. Post-irradiation hemagglutination-inhibition (HI) antibody levels were temporarily lower than preirradiation titers, but returned to normal levels by the end of the 2nd week after vaccination. The explanation offered for this decrease is that irradiation after vaccination interrupted the synthesis of macroglobulin antibodies and delayed the appearance of 7S γ-globulin antibodies. These experiments provide additional evidence that the early portion of the immune response in mice is sensitive to the injurious action of ionizing radiation. The peak of HI activity due to macroglobulin antibodies normally precedes the peak due to 7S γ-globulin activity and this dissociation of HI activities is not clearly observed in normal mice unless each activity is measured separately. X irradiation three days after administration of influenza viral antigen exaggerated that dissociation of antibody activities by prematurely interrupting macroglobulin synthesis and delaying the appearance of 7S γ-globulin, resulting in two distinct HI peaks. These results suggest the possibility that dual peaks of hemolytic activity described in rats and mice exposed to x rays after injection of sheep red cells might also be due to comparable effects on macroglobulin and γ-globulin synthesis in those experiments. (BBB)

13015 PATHOGENESIS OF SCRUB TYPHUS INFECTION (RICKETTSIA TSUTSUGAMUSHI) AS STUDIED BY IMMUNOFLUORESCENCE. W. D. Kundin, Chien Liu, Patricia Harmon, and Patricia Rodina (Univ. of Kansas, Kansas City). J. Immunol., 93: 772-81(Nov. 1964).

The fluoresent antibody technique was used to follow the course of infection of scrub typhus in suckling and weanling mice, and the effects of x irradiation and differing routes of inoculation on the distribution of rickettsial antigens. This technique was also employed in attempts to locate rickettsiae in mice up to a year after initial infection. Although the susceptibility and length of survival of mice infected with the Karp strain of scrub typhus varied with the age of the host, the size of the inoculum, the route of inoculation, and the exposure to irradiation, antigenic involvement in all cases appeared to follow a unified pattern. Rickettsial growth was confined to tissues of mesenchymal origin. To determine the influence of the effects of x irradiation on antigenic involvement, groups of unirradiated mice and mice which had received 400 R of whole-body x irradiation 24 hr previously were inoculated. All infected irradiated mice died within 28 days, as did all but one of the unirradiated inoculated mice. Irradiation shortened the

hosts' survival time regardless of the route of inoculation. The intraperitoneal and intracerebral inoculations yielded 98% mortality. Subcutaneous and intramuscular inoculations yielded similar mortality rates in x irradiated mice, but in normal animals about two thirds survived. Although all irradiated mice in the subcutaneous and intramuscular routes died within 28 days, they survived about a week longer than after intracerebral or intraperitoneal injections. (BBB)

13016 ULTRAVIOLET-INDUCED CORNEAL TUMORS IN DIFFERENT SPECIES AND STRAINS OF ANIMALS. Robert G. Freeman and John M. Knox (Baylor Univ., Houston, Tex.). J. Invest. Dermatol., 43: 431-6(Nov. 1964).

Rats, mice, and hamsters all responded to uv by developing skin damage and clouding of the anterior chamber of the eye. In contrast, no guinea pigs developed eye tumors or manifested any eye changes as a result of uv exposure although they, like the other animals, received skin erythema doses daily five times per week. In rats the tumor occurrence was greater in pigmented strains than in the albino strains. Tumors grew more rapidly in pigmented mice and hamsters than in nonpigmented strains, a difference being significant at 180 days. When irradiation was continued, nonpigmented animals eventually developed tumors and this frequency approached or equaled the frequency of pigmented animals. Within six weeks after beginning uv exposure, the anterior chamber of the eyes of pigmented rats and mice became clouded. Microscopically, this white material in the anterior chamber consisted of fibrin strands with occasional leukocytes. Clouding was not observed in albino rats nor in hamsters or guinea pigs. The first evidence of tumor formation occurred during the fifth month when small opacities appeared in the cornea of many pigmented animals and a few nonpigmented ones. Then, white or red nodules appeared in the central cornea. They had a smooth surface covered by epithelium, and, as they grew, ulceration often occurred. They extended toward the limbus and bulged into the anterior chamber and externally. Red vascular tumors and the white fibrous tumors developed which had the appearance of hemangioendotheliomas and fibrosarcomas respectively. Two-thirds were classified histologically as fibrosarcomas. The extreme vascularity of some explained the observation that one-half the tumors were red but only one-third were hemangioendotheliomas microscopically. The tumors arose in the corneal stroma and were separate from the corneal epithelium and endothelium in early stages. Significance of the observation that pigmented animals of several species develop tumors of the cornea more readily than their corresponding albino strains is discussed. Pigment appears to be the common underlying factor since several strains of three different species reacted similarly when pigment was present. Melanin usually protects against uv injury in the skin, the finding of an adverse effect of pigment on a light-induced injury is surprising and not readily explainable. (BBB)

13017 AN APPROACH TO THE DETERMINATION OF THE MAXIMAL CONTRIBUTION OF THYMINE DIMER TO ULTRAVIOLET-INACTIVATION OF BACTERIOPHAGE T4vx. Walter Sauerbier and Alfred Haug (Universität, Cologne). J. Mol. Biol., 10: 180-2(Oct. 1964).

The role of thymine dimers in the photoinactivation of the biological functions of double-stranded DNA is investigated on the basis of the following assumption. Thymine dimer is not the only lethal photoproduct; there exists at least one other lethal photoproduct, X. If conditions are found to reduce the quantum yield for producing X, and if simultaneously the quantum yield for the formation of thymine dimer is reduced to a less extent than for X (or unchanged, or even increased), then it should be possible to increase the ratio thymine dimers/hits for a given biological object. By such manipulations an upper limit for the lethality of the thymine dimer can be determined. Phage T4vx was used, in which no reactivation phenomena are known to complicate the comparison between biological assay and photochemical alterations in the DNA. The biological function studied was the plaque-forming capacity after direct plating with indicator bacteria Escherichia coli B. The survival of T4vx was determined following 315 mμ irradiation in oxygen-saturated buffer at pH 7, and the ratio thymine dimers/lethal hits was determined. The highest ratio thymine dimers/hits was 7.1. If all the lethal effect is due to thymine dimer, then only one out of seven thymine dimers is lethal. If the possible role of neighboring bases is neglected in determining which one out of the seven thymine dimers is lethal, every thymine dimer per se has at best a 1/7 chance to be lethal. Transferring this observation to the results obtained with 260 mμ-inactivation (2.4 thymine dimers/hit) suggests that the maximal contribution of the thymine dimer to T4vx inactivation at 260 mμ irradiation is $2.4 \times 1/7 = 0.34$/hit. This means that, in the double-stranded T4vx DNA the lethal photoproduct $X_{(a)}$ is produced with a frequency of at least 0.66 per phage lethal hit at 260 mμ. Comparable results were obtained with $T4vx^+$. Also with $T4vx^+$ the rate of thymine dimerization with 315 mμ-irradiation is linear at least up to 135 hits, which equals about 270 hits in T4vx. (BBB)

13018 HISTOCHEMISTRY OF PARTICLE MICROBEAM LESIONS IN THE BRAIN OF THE MOUSE. T. Samorajski, W. Zeman, and J. M. Ordy (Cleveland Psychiatric Inst.). J. Neuropathol. Exptl. Neurol., 23: 264-79(Apr. 1964).

A histochemical study was made of early and sequential neuronal and vascular changes in the pathogenesis of deuteron microbeam lesions, and an attempt was made to correlate these histochemical alterations with the histologically demonstrable changes in the brain tissue at later postirradiation intervals. CF_1 mice were irradiated with 20-Mev deuterons either as a 1-mm beam at 8000 Rad directed to the parietal cortex or a slit microbeam measuring 9.0×0.025 mm delivered at 115,000 Rad in a parasagittal position about 0.5 mm from the interhemispheric fissure. In other experiments C57Bl/10 mice were exposed to multiple microbeams which irradiated them bilaterally in the left and right parietal areas with 1-mm circular microbeams and across the visual cortex with 9.0×0.025 mm slit microbeams, at a distance of 2.5 mm posterior to the circular beams, again at 8000 and 115,000 Rad respectively. Lesions produced with 9.0×0.025 mm slit microbeams at 115,000 Rad were already observable at three days in the deep regions of the brain stem where the adsorbed tissue dose was maximum (Bragg zone). At this time, pyknotic nuclei of neuronal and neuroglial cells were easily identified. By five days, the entire course of the beam path was clearly indicated by a complete destruction of neuronal and neuroglial elements. Following the disappearance of the cells, no further changes were observable. With a 1-mm beam at 8000 Rad the earliest morphologic alterations occurred after five days and were confined to the Bragg zone. They consisted of cell pyknosis, endothelial swelling, hemorrhage, and leukocyte infiltration; this zone became totally necrotic by 21 to 25 days after irradiation. The nonsignificant changes in alkaline phosphatase activity in brain tissue irradiated with slit microbeams suggested that vascular disturbances may play a relatively minor role in the early and delayed cell necrosis in such microbeam lesions. In contrast, lesions produced by 1-mm beams showed decreased alkaline phosphatase activity which preceded cell necrosis. Early direct cellular damage was identified by a conglomeration of particles rich in acid phosphatase and cathepsin type-C esterase. Both reactions decreased subsequent to cellular autolysis. At later postirradiation stages, an increase in glial acid phosphatase activity was observable in the irradiated white matter suggesting repair of damaged interstitial glial and endothelial elements as demonstrated by uptake of injected ^{3}H-thymidine. The severity of early and delayed vascular damage was related to beam dia, volume of irradiated tissue, and caliber of blood vessels. In general, increasing beam diameters produced increasing circulatory damage and greater latency as well as variability in both cellular and vascular radiation injury. Histochemically, the irradiated vessels developed hyalinization, became PAS positive, and were characterized by a deposition of PAS-

positive globules in the perivascular regions. These findings show that neurons are directly susceptible to ionizing radiation in the presence of negligible vascular damage, indicating that early neuronal and vascular damage may occur independently, with various delayed histochemical differences becoming apparent in sequential or concurrent time relation during pathogenesis. (BBB)

13019 A STUDY IN CHRONIC BRAIN RADIONECROSIS. R. H. Brownson, W. M. Shanklin, and D. B. Suter (Medical Coll. of Virginia, Richmond). J. Neuropathol. Exptl. Neurol., 23: 660-75(Oct. 1964).

Male, 30-day-old rats received a single dose of restricted head x-irradiation dose of 4500 R at 550 R/min and were sacrificed 76 to 79 days after exposure. All of the irradiated animals displayed signs of physical and behavioral change prior to sacrifice. The brains removed from these animals demonstrated evidence of gross alteration in structure within an area approximating the diameter of the x-ray beam. Three zones of tissue alteration were detected microscopically by histochemical and histological methods. These zones were arbitrarily divided as follows: A zone, center of necrosis, B zone, area of degeneration and repair, and C zone, essentially normal area. Staining and impregnating methods, oxidative and hydrolytic enzyme methods both served to characterize the changes in these zones described. The areas of central necrosis were multiple and showed extensive loss of structure. These areas contained phagocytic cells and closely packed finely granular material. The areas of repair were intensely enzymically reactive, showing heavy deposits of formazan. A considerable amount of the increased formazan deposition was primarily associated with enlarged fibrillary astrocytes, swollen microglia, proliferating blood vessels, and degenerating neurons. Evidence of change in the character and localization of acid phosphatase was also noted in neurons. Other technics showed a variety of alterations in both intracellular and extracellular loci within all zones identified. Diastase-digestible and diastase-nondigestible PAS-positive globules of various sizes were observed in irradiated tissues. In A and B zones the accumulation of these globules was massive and often lipid-associated. In necrotic and proliferation areas the globules were associated with blood vessels and astroglia. Reactions observed with the PAS reaction could also apply to the OTAN reaction. That is, OTAN-positive material (unsaturated lipids) was seen in amounts and location similar to the PAS-positive carbohydrates. (BBB)

13020 RESISTANCE TO TRICHINOSIS IN SWINE INDUCED BY ADMINISTRATION OF IRRADIATED LARVAE. P. B. Cabrera (Wayne County General Hospital, Eloise, Mich.) and S. E. Gould. J. Parasitol., 50: 681-4 (Oct. 1964).

As shown earlier, resistance to trichinosis can be induced in rats by preliminary infection with larvae of Trichinella spiralis exposed to 6000 to 10,000 rep of ^{60}Co radiation. These doses cause morphologic alterations in the developing adult worms, and sharp decrease in, or loss of, ability to reproduce. An immune response to trichinosis develops in experimental animals after infection with larvae that had been exposed to x irradiation, and this method of vaccination conceivably could be applied to persons as a public health measure in certain parts of the world, where flesh of animals is eaten raw. Present study was designed to determine if resistance to trichinosis can be induced by swine by feeding them trichina larvae exposed to ^{60}Co irradiation. Group A consisted of pigs initially infected with 50,000 nonirradiated larvae; Group B of pigs initially infected with 50,000 larvae irradiated with 10,000 rep; Group C of pigs given a primary infection of 100,000 nonirradiated larvae; Group D of pigs infected with 100,000 larvae irradiated with 10,000 rep. In Group A the slight rise observed in the larval count meant that resistance to reinfection was induced by the primary infection. In Group B fed 50,000 irradiated larvae and killed 49 days later, the lower average larval count indicated that the preliminary infection with irradiated larvae produced significant resistance to reinfection. A comparison of the findings in pigs of Groups C and D also revealed that resistance to reinfection was induced by an initial infection with 100,000 irradiated larvae. Group B largely withstood a reinfecting dose of 50,000 nonirradiated larvae 49 days later, while in Group D the resistance was only partially overcome by a reinfecting dose of 100,000 nonirradiated larvae. The titer of trichina antibodies in pigs after the initial infection was considerably higher in those fed irradiated larvae. Pigs of Group A and Group C showed elevation of the serum γ-globulin two to four weeks after infection, some depression of the albumin, and no significant changes in the α- and β-globulins. After seven weeks the values returned to the preinfection levels. It is concluded that oral administration of irradiated trichina larvae to pigs can induce resistance to reinfection with non-irradiated larvae of T. spiralis. (BBB)

13021 EFFECT OF WHOLE-BODY X-IRRADIATION ON RAT LIVER GLYCOGEN PHOSPHORYLASE ACTIVITY. Michio Matsuba, Nagasumi Yago, and Shigeru Kobayashi (Jikei Univ., Tokyo). Jikeikai Med. J., 11: 24-32(Apr. 1964).

The activity of liver glycogen phosphorylase and the content of liver glycogen of rats were determined at various time intervals up to 72 hr after a single lethal dose (1000 R) of whole-body x irradiation. In nonirradiated, fasted control rats the hepatic glycogen phosphorylase activity decreased progressively with time up to 72 hr, and the amount of liver glycogen fell to a negligible level within 24 hr of fasting. In the irradiated, fasted rats that were irradiated at the start of the fasting period, glycogen phosphorylase activity did not decrease over a 72-hr period after irradiation, and the glycogen storage levels were markedly higher than the fasting levels. In comparison with the nonirradiated, fasted controls, the enzyme activity 3 hr after irradiation was lower in rats fasted for 24 hr prior to x irradiation. In another experiment, animals were allowed access to food ad libitum before and after exposure to x rays; both control and irradiated (1000 R) rats were given the same diets. Assay of hepatic glycogen phosphorylase at 24 and 48 hr after irradiation revealed no significant changes due to irradiation, but this was followed by a drop to about 60% of that of the nonirradiated, ad libitum fed animals. The hepatic glycogen content of these rats decreased almost linearly with time. Their daily food intake reduced progressively and stomach contents increased significantly. Since both hepatic glycogen storage level and glycogen phosphorylase activity were consistently higher in the irradiated animals than in fasted control animals at all time intervals, it is possible that the higher enzyme activity in the irradiated animals may be maintained, at least partly, by the higher than control level glycogen reserves. Early effects of x irradiation on the hepatic glycogen phosphorylase, that is, the enzyme level being lower in the fasted, irradiated rats than in the fasted control rats, might imply that the stability of hepatic glycogen phosphorylase to whole-body x irradiation is disturbed in the fasted, irradiated rats, since the substrate glycogen has been already exhausted during 24-hr fasting. (BBB)

13022 RADIOBIOLOGY. [PART] I. Honjo Ichijiro and Yuong-tchel Tchoe [Osaka Univ.]. Kagaku No Ryoiki, 17: 313-22(1963). (In Japanese)

This is the first member of a 12-part series on radiobiology. A brief history of radiation science is given tracing the developments in this field since the original work of Roentgen and Becquerel. Attention is called to the large quantity of radioactivity already present on this earth along with the amount that is continually being added. This points to the need of the study of radiation effects on biological systems even without the radiation that is now being contributed by man. Special consideration is given to the fundamental aspects of interactions between ionizing radiation and matter, and the concepts of stopping power and LET are introduced. The passage of charged particles, electromagnetic radiation, and neutrons through matter are discussed, and the various mechanisms of energy dissipation and transfer are considered. The spacial distribution of ions created by ionizing radiation is discussed. (TTT)

13023 RADIOBIOLOGY. [PART] II. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 17: 396-403(1963). (In Japanese)

Units used to describe quantities of radiation and their measurement are discussed. The Roentgen and Rad units are defined, and their interconversion is described. This is followed by a discussion of depth dose and the energy dissipated in creating an ion pair. Other units that are introduced include RBE (relative biological effectiveness), Rem (roentgen equivalent man), effective half life, and biological half life. The subject of dosimetry is next considered. The relative merits of calorimetry, ionizations chambers (free air ionization chamber, cavity ionization chamber), and chemical dosimeters are compared. Chemical dosimetry is concerned almost entirely with the Fricke ferrous sulfate dosimeter and only a passing mention of the ceric dosimeter is included. (TTT)

13024 RADIOBIOLOGY. [PART] IV. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 17: 545-6(1963). (In Japanese)

Radiation effects on macromolecules, particularly those of biologic interest, are reviewed. Structural changes to macromolecules (degradation, crosslinking) are described in relation to dose. Structural and chemical changes that result from the irradiation of proteins, enzymes, nucleic acids, and nucleoproteins are also considered. Many unusual effects observed on the irradiation of monomolecular films are cited. Most of these films are formed by adsorption on surfaces such as ion exchange resins. Radiation effects on colloids are also discussed. This deals primarily with changes in zeta potentials with dose of several types of sols tied in with possible physical and chemical changes brought about by irradiation. (TTT)

13025 RADIOBIOLOGY. [PART] V. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 17: 632-44(1963). (In Japanese)

Mechanisms of interactions between radiation and biologically important materials are discussed. These interactions can take place by direct or indirect action. Direct action is explained in terms of the multihit model (single or multiple targets) or the multitarget model (single or multiple hits). Special consideration is given to those cases in which LET values are high. Factors that cause deviations from the normal dose effect curve are enumerated. The use of radiation to investigate structure and orientation of viruses is described. Indirect action is when an irradiated molecule diffuses to another locale and imparts energy it acquired to another molecule to cause changes in the second molecule. The concept of D_{37} (37% dose) is defined. The decrease in reaction speed of macromolecules suspended in aqueous medium following irradiation is treated mathematically. Interrelation between direct and indirect actions is described. These two modes of action can be differentiated by dilution, freezing, or dehydration studies. There are systems in which both direct and indirect actions can take place, and that of tobacco mosaic is given as an example. (TTT)

13026 RADIOBIOLOGY. [PART] VI. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 17: 721-9(1963). (In Japanese)

Environmental factors that influence radiation effects are discussed. These factors come into play in changes at molecular levels (10^{-5} sec) and biochemical and biophysical changes take place at the second, minute, or hour level. Presence or absence of oxygen has profound effect on radiolytic changes in living systems. Oxygen has to be present at the time of irradiation for most pronounced effects, and these effects are readily seen with beta or gamma irradiation but are relatively minor with radiation of high LET (neutron, alpha). Oxygen effects are described in quantitative manner as a function of its concentration. Effects observed when material is exposed to oxygen before or after irradiation also are described. A mechanism in which oxygen is involved in the radiolytic process is presented. Other gases whose effects are mentioned include nitric oxide, hydrogen, nitrogen, and nitrous oxide. (TTT)

13027 RADIOBIOLOGY. [PART] VIII. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 17: 950-8(1963). (In Japanese)

Parameters associated with sensitivity or resistance to radiation are discussed. All living things do not have the same resistance to radiation and exhibit varying degrees of sensitivity according to specie. Mammals are most sensitive while the lower and simpler forms of life show greatest resistance. There are several orders of magnitude difference in going from the most sensitive to the least sensitive in the lethal dose or LD_{50}. Radiosensitivity is also associated with age. For example, nerve cells from a placenta are much more sensitive than nerve cells from an adult. Another parameter tied in with radiosensitivity is cell ploidy. Resistance to radiation increases from haploid to diploid, triploid, tetraploid. Other factors discussed in relation to radiosensitivity are size of chromoplasts and nature of cell material. Some lower forms of life develop resistance to radiation with repeated exposure. This is also noticed with higher animals even including mammals. (TTT)

13028 RADIOBIOLOGY. [PART] X. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 18: 243-51(1964). (In Japanese)

Radiation effects on DNA and other biologically important materials are discussed. Radiation is known to interfere with the synthesis of DNA. The cycle of DNA synthesis is outlined illustrating the various steps necessary for its replication. It is not yet clear what specific radiation effects interfere with this chain of reactions. Since DNA synthesis accompanies cell scission, it seems reasonable that any interference with the scission process will result in reduced production of DNA. In vivo studies of radiation damage to DNA are described with specific examples. Some radiation effects that could possibly be tied in with the hindering of DNA production are discussed. These include interference with cell scission, interference prior to the initial synthesis stage, and interference during actual synthesis. Finally, a mechanism to explain radioinduced interference with DNA production is described. (TTT)

13029 RADIOBIOLOGY. [PART] XI. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 18: 511-21(1964). (In Japanese)

Radiation effects on the synthesis of RNA are reviewed. The steps involved in this synthesis are described followed by treatment of in vivo and in vitro studies related to the effects of radiation on this synthesis. Radiation effects on the synthesis of proteins are also reviewed. The mechanism of protein synthesis involving participation by both RNA and DNA molecules is described. Studies utilizing carbon-14 labeled amino acids indicate that protein synthesis within a cell is fairly resistant to radiation, however, that taking place in a nucleus is much more sensitive. Radioinduced interference of in vivo protein synthesis is believed to be due to inactivation of DNA molecules that play an important role in the synthetic scheme. Radiation also inhibits antibody production. Studies are described that illustrate the nature of this inhibition, and two possible mechanisms are listed. Radiation chimera is briefly discussed. (TTT)

13030 RADIOBIOLOGY. [PART] XII. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 18: 744-57(1964). (In Japanese)

Radiation effects on biological materials are reviewed. Radiation causes many nucleoproteins to dissociate. In vivo irradiation of oxygen is quite different from in vitro in that a strong post irradiation activation effect is observed. Radioinduced oxygen effects on RNase, DNase, and enzyme release are described. Radiation damage to cells can be classified under somatic and genetic effects. Radioinduced interference in the mitotic process is discussed, and several causes of cell death are listed and described. Effects of radiation on chromosomes can appear in the form of rupture or chromosome aberration. The latter is a genetic effect that can result in chromosome terminal deletion, interstitial deletion, inversion, duplication, translocation, chromatid deletion, isochromatid deletion, intrachange, or interchange. The quantitative response of chromosome ab-

erration to dose is shown, and the relation between RBE and LET associated with chromosome damage is discussed. Factors that play important roles in this degenerative process are described, and a mechanism of radiation damage to chromosomes is presented. (TTT)

13031 EFFECT OF X RAYS ON NUCLEIC ACID OF YOSHIDA'S SARCOMA. Takuzo Shimizu (Gunma Univ., Maebashi, Japan). Kitakanto Igaku, 12: 237-49(July 1962). (In Japanese)

In this study a chemical method was used to determine the nucleic acid concentration per cell of Yoshida sarcoma, and from its changes the effect of irradiation on the cell was investigated. At 4 to 7 days after transplanting the sarcoma into rats, they were abdominally irradiated with single doses of 100, 200, 500, and 10,000 R. After various times, ascitic fluid was taken, from which nucleic acid was extracted by the Schneider method. Then DNA and RNA contents per cell were colorimetrically determined by the diphenylamine reaction and orcinol-HCl reaction, respectively. Normal Yoshida sarcoma gave relatively constant values, the DNA content per cell being $10.65 \pm 0.45 \times 10^{-6}$ μg, and RNA content $17.98 \pm 1.16 \times 10^{-6}$ μg. After irradiation with 100 R, both DNA and RNA showed a slight increase at one hr, but at three hr they returned to the initial values, exhibiting thereafter no remarkable changes. After irradiation with 200 R, no change appeared as late as three hr, but an appreciable increase occurred at 6 hr, more markedly in RNA than in DNA. The values fell transiently at 12 hr, but again rose at 18 hr, returning to the initial level at 24 hr. After irradiation with 500 R, DNA showed no change, while RNA showed a slight increase at 18 hours to 24 hr. After irradiation with 10,000 R, neither DNA nor RNA showed any definite change. A consistent relation could be seen between changes in nucleic acid and number of cell division. After irradiation with 100 R, cell division decreased to the minimum level at one hr, rising abruptly thereafter, in correspondence with the increase in nucleic acid. The same relation was observed at six hr after irradiation with 200 R, but no consistent relation was obtained after irradiation with 500 R. (BBB)

13032 ON THE PATHOGENESIS OF COMBINED MALFORMATIONS OF THE LENS AND CORNEA IN THE EYES OF NEWBORN MICE, WITH PARTICULAR REFERENCE TO DISTURBANCES IN THE SEPARATION OF THE EMBRYONAL LENS VESICLE FROM THE SURFACE ECTODERM. G. Badtke and K. H. Degenhardt (Universitat, Halle/Saale, Ger.). Klin. Monatsbl. Augenheilk., 142: 62-89(Feb. 1963). (In German)

Two broods of pregnant female mice were irradiated on the eighth day of gestation with 130 R of 250-kv x ray, at a rate of 60 R/min. The malformed eyes from 7 of the offspring were studied histologically and morphologically. There were 13 cases of microphthalmus, 9 with colobomas, 1 with an intraocular cyst, 6 total aphakias, where 1 cornea was completely missing, 6 cases where the lens failed to separate from the corneal epithelium and a very small lens with sharp borders was located in a corneal defect. There was no sign of inflammation, and the lens epithelium had grown to the corneal epithelium. Microphakia was also noted. In 4 cases the lens contents were about to enter the connective tissue sac. In one case the lens was forming a fiber bundle. In two lenses lentoid formation was unstable. Other secondary malformations were observed. Primary inflammation from irradiation was not the cause for all these defects. One possible reason might have been that the cornea was injured enough to prevent development of the descemetic organ and the corneal parenchyma. The lens would have formed within this defect, the epithelium would degenerate, and after rupture of the lens capsule the contents could enter the connective tissue sac. This could also account for the secondary defects observed. Apparently, the developing eyes were irradiated at a time when they were extremely susceptible to injury. Effects observed in the cornea may have been secondary to those imposed on the developing lens. The changes observed are discussed in considerable additional detail in terms of their possible pathogenesis, physiology, and teratogenesis. (BBB)

13033 THE COMBINED ACTION OF ANTI-TUMOR CHEMICALS AND ^{60}Co GAMMA RAYS ON THE MOUSE STRAIN L CELLS CULTURED IN VITRO. I. EFFECT OF MITOMYCIN C. Yoshisada Fujiwara, Takashi Aoyama, and Teruo Kondo (Kobe Medical Coll., Japan). Kobe J. Med. Sci., 10: 47-54(Apr. 1964).

Mitomycin C (MC), an anti-tumor antibiotic obtained from the culture filtrate of Streptomyces caespitosus, selectively inhibits the synthesis of DNA without affecting that of RNA and protein in mammalian cell lines. Observations on the mechanism of inhibition of DNA synthesis by MC have revealed that the inhibition might be caused by either suppressed polymerization or accelerated degradation of DNA. On the other hand, it has been postulated that damage to cells from irradiation, expressed as reproductive death, is exerted through mediation of lesions induced in DNA. It should then be of interest, theoretically as well as practically, to test whether radiation and MC show a synergistic or antagonistic action on mammalian cells when both treatments are supplied at various intervals of time. In this study the combined effects of MC and ^{60}Co γ radiation are reported in experiments using the reproductive integrity of mouse strain L cells cultured in vitro as an indicator. Radiation doses of 100 to 1000 R were used. A final concentration of 0.01 μg/ml of MC was chosen, because higher concentrations of MC made it impossible to analyze the combined effect on account of the very low proliferation rate of the cells. Even with this low level of MC, modification by MC of radiation effects at various doses showed wide variations according to the time and length of administration of the drug. In pretreatment experiments in which MC was administered to the cells previously and removed immediately before irradiation, treatment with MC made the cells more radioresistant. This might be caused because MC inhibited the synthesis of DNA, so that the cells in G_1 and G_2 phase, which are known to be relatively radioresistant, occupied the larger proportion of the cell population. In other words, the radiosensitive cells in S phase and/or in mitosis were reduced in number at the time of irradiation, resulting in the apparent reduction in radiosensitivity of the cells after 7-day incubation. Or, alternatively, MC reduced the all-over metabolic activity of the cells, and the cells of low metabolic activity were more resistant to irradiation than those of high metabolic activity. In posttreatment experiments, in which MC was added to the medium after irradiation and maintained at that level until cell counting, an additive effect of radiation and MC was observed. In the simultaneous treatment, in which irradiation was performed in the presence of MC, a strong synergistic action was seen. This might be caused by enhanced passage of MC across the cell membrane due to irradiation, a phenomenon seen with mouse Ehrlich ascites tumor cells. It is concluded that a synergistic action is obtained only with the simultaneous administration of MC with irradiation, and that no enhanced cytocidal effect of irradiation can be obtained by pre- and post-treatments with MC. (BBB)

13034 HOMOTRANSPLANTATION OF KIDNEY IN PATIENTS TREATED BY PREOPERATIVE LOCAL IRRADIATION AND POSTOPERATIVE ADMINISTRATION OF AN ANTIMETABOLITE (IMURAN). REPORT OF SIX CASES. M. F. A. Woodruff, J. S. Robson, B. Nolan, Anne T. Lambie, T. I. Wilson, and J. G. Clark (Royal Infirmary, Edinburgh). Lancet, 2: 675-82(Sept. 28, 1963).

Transplantation of the kidney was carried out in nine patients. The first patient, who received a kidney from his identical twin, remains in good health with normal renal function more than two and a half years after operation; the second, who received a kidney from her brother after being given whole-body irradiation, died from septicemia 30 days after operation with a graft which showed only slight histological evidence of immunologic damage. The eighth patient, like the first, received a kidney from an identical twin, and progress so far has been very satisfactory. The other six patients received a kidney from a parent (five cases) or

non-twin sibling (one case). In view of earlier unsatisfactory experiences with whole-body irradiation, chemotherapy in the form of long-continued administration of Imuran was used to supplement irradiation to modify the homograft reaction. Chemotherapy was combined with preoperative local irradiation (100–200 Rad) of the spleen and the graft site using either a 4-Mev linear accelerator or a 2-Mev Van de Graaff generator. This was given to reduce the general lymphoid cell population and to damage the lymph nodes in the region of the graft. Renal function in one of the recipients (case 3) nine months after transplantation is good, and it seems unlikely that this transplant will now be rejected. Three other patients, whose grafts have been in place for periods ranging from 3 to 8 months, are alive with creatinine clearances ranging from 12 to 30 ml/min. All show some evidence of an immunologic reaction adversely affecting the transplant. One of the patients died. In the other unsuccessful case (case 6) the transplant continued to function moderately well up to the time of death 2 months after transplantation, and at necropsy no histologic evidence of immunologic rejection was evident. The combination of local irradiation and chemotherapy which was used takes advantage of the fact that irradiation lends itself to direction in space, and chemotherapy to control in time. It appears to be safer than whole-body irradiation and makes it possible to obtain significant suppression of the homograft reaction without seriously depleting either the patient's polymorphonuclear leukocytes or his blood platelets. (BBB)

13035 EXPERIMENTAL DATA ON THE IRON METABOLISM OF IRRADIATED PATIENTS. Geza Adam, Erzsebet Pongor, Istvan Berta, Andras Molnar, and Gabor Jona (Debreceni Orvostudomanyi Egyetem Rontgenklinikaja, Debrecen, Hungary). Magy. Radiol., 16: 285-8(Oct. 1964). (In Hungarian)

Tests were made on irradiated patients to determine the changes of serum iron tolerance curves after oral and parenteral iron intake. The patients were divided into groups of 50, of which 40 received abdominal irradiation and 10 thoracic irradiation. The ^{59}Fe isotope was used, in 1.5 mg/kg amounts of ferrum reductum. In oral loading tests the serum Fe level reached its max after 4 hr and normalized after 24 hr in both irradiated groups. Results were as follows: at 0 hr, prior to abdominal irradiation 109.2 $\mu g\%$, postirradiation, 93.3 $\mu g\%$, prior to thoracic irradiation, 126.6 $\mu g\%$, postirradiation 101.1 $\mu g\%$; the corresponding values were at 2 hr 191, 135.1, 206.1, 160.5; at 4 hr, 246, 171.3, 242.2, 202.6; at 6r, 184.1, 134, 219.4, 176.1; at 24 hr, 94.6, 81, 116.4, 94.4. In the parenteral tests when 4 ml of Ferronascin was injected, the results showed that the serum Fe level increased five-fold after 2 hr and normalized after 24 hr. Results were as follows: 0 hr, prior to abdominal irradiation, 106.3 $\mu g\%$, postirradiation, 110.3 $\mu g\%$, prior to thoracic irradiation, 115.3 $\mu g\%$, postirradiation, 107 $\mu g\%$; at 2 hr the corresponding values were 551.9, 593.1, 545.3, 561.5; at 4 hr, 443.5, 470.3, 448.5, 494.2; at 6 hr, 395.5, 391.1, 383.8, 423.1; at 24 hr, 110.8, 105.6, 102, 107. It is suggested that irradiation seriously disturbed electrolyte balance, including Fe exchange. It is therefore insufficient to attempt to supplement the Fe requirements in irradiated patients by orally administered Fe preparations; parenterally administered Fe preparations proved much more efficient. (BBB)

13036 THE SURVIVAL AND REGENERATION OF THE WHITE BLOOD CELLS IN IRRADIATED RATS TREATED WITH BATYL OR SELACHYL ALCOHOL. P. Bassi and A. Dunjic (Universita, Parma, Italy). Minerva Fisioterap., 7: 59-62(Mar.-Apr. 1962). (In Italian)

Adult rats were irradiated with 250-kv x rays at a rate of 42 R/min measured in the air by an ionization chamber. The animals were divided into 400-R and 500-R dose groups and again subdivided into groups that were subcutaneously injected with a batyl alcohol-peanut oil suspension, selachyl alcohol, and a control group (peanut oil only). The $LD_{50/30}$ for these animals was 450 R. The animals received a dose of 2 mg of the test alcohol dispersed in 0.16 ml of peanut oil on the first day after the irradiation and then on alternate days until a total dose of 10 mg was reached. Blood samples were taken on the 1st, 3rd, 6th, 9th, 13th, 20th, and 30th days. In the 400-R group the maximum white blood cell (WBC) drop was observed for the control, batyl, and selachyl alcohol groups in the first three days, with a slightly higher level between the third and tenth days for the batyl and selachyl alcohol groups. WBC restoration was observed on the tenth day in the batyl alcohol group, followed by the selachyl alcohol and control groups on the 13th day. The cell count was similar for all three groups on the 29th day. On the 30th day the lowest value was observed in the batyl alcohol group and near equal counts in the control and selachyl alcohol groups. Neutropenia was manifested on the third day, and the neutrophil count remained low until the 13th day, followed by a slow restoration in the selachyl alcohol and control groups. Near initial levels were reached on the 20th day in the 400-R group, with slower regeneration in the 500-R group, reaching the initial value on the 30th day. In the 400- and 500-R batyl alcohol groups below normal values were observed on the 30th day. After 400 R, lymphocyte changes were the same for the three groups. In the 500-R group the regeneration of lymphocytes also began on the 13th day and the three groups overlapped until the 20th day; then, the highest value was observed in the control, followed by an intermediate value in the selachyl alcohol, and the lowest value in the batyl alcohol group. Thus, treatment with batyl and selachyl alcohols did not favorably influence the lymphocyte changes. (BBB)

13037 EFFECTS OF IRRADIATION OF THE CENTRAL NERVOUS SYSTEM ON GLYCEMIA: OBSERVATIONS IN THE COURSE OF X-RAY TREATMENT OF CEREBRAL NEOPLASIA. C. Crosta (Universita, Milan). Minerva Fisioterap., 7: 62-6(Mar.-Apr. 1962). (In Italian)

Changes in blood glucose levels were followed in 11 patients irradiated for brain tumors. Their tumors were situated as follows: (1) neoplasm of the pons, (2) hypophysial adenoma, (3) neoplasm in the third ventricle, (4) left parietal meningoma, (5) third ventricle tumor, (6) left temporal glioma, (7) right frontal glioma, (8) right frontal temporal glioma, (9) left frontal temporal tumor, (10) third ventricle tumor, and (11) cerebellar neoplasm. Patients one, two, and three were not operated upon, but the neoplasms were surgically removed from cases four and five. Patients six, seven, eight, nine, ten, and eleven received only exploratory and decompressive surgery. All patients received a total irradiation dose of 6000 R of 180-kv x rays over a field of 7×10 cm and fractionated in 150-R daily doses. In patients (3), (5), (7), (8), (9), (10), and (11) the fasting glycemia level was determined before therapy and 24 hr after each irradiation. Glucose tolerance tests were conducted in some, each patient receiving 50 g of glucose immediately after the first irradiation, and glycemia values were observed each half hr for four hrs. One group showed relatively constant fasting glycemic values during the entire therapy period. Thus, in cases (5), (6), (7), (8), and (11) a slight drop in blood glucose followed therapy, then normal values were regained. In six patients, (1), (2), (3), (4), (9), and (10) greater fluctuations were noted after irradiation. Glucose tolerance tests conducted with an oral dose of 50 g glucose demonstrated that 150 R does not induce any particular alteration in glucose tolerance, either in the max values, duration of the hyperglycemic period, and rate at which the values return to normal. All four patients who received glucose prior to irradiation showed identical tolerance curves. This study demonstrated that an initial brain irradiation may be followed by a slight fall in glycemia and an increase in fluctuation of the levels, otherwise the values remain normal. The fractionated total irradiation dose produced in some cases a slight decrease in the glycemic values over the whole period of treatment. Irradiation of the blood vessels in the hypothalamus region could be the cause of the initial transient fluctuation in glycemia. (BBB)

13038 ON THE NON-REQUIREMENT FOR DEOXYRIBONUCLEIC ACID SYNTHESIS IN THE PRODUCTION OF CHROMOSOME ABERRATIONS BY 8-ETHOXYCAFFEINE.

D. Scott and H. J. Evans (Medical Research Council, Harwell, Berks, Eng.). Mutation Res., 1: 146-56(July 1964).

A combined treatment with [^{3}H] thymidine and 8-ethoxycaffeine (EOC) was used on Vicia roots to investigate the sensitivity of the various phases of the cell cycle to aberration induction and mitotic delay. In contrast to most other radiomimetic chemicals, which induce chromatid aberrations at the time of DNA synthesis, EOC was most effective in inducing aberrations in cells exposed whilst in the post-DNA-synthesis, or G_2, phase. The action of EOC is therefore independent of the normal processes of chromosome duplication, but may be related to other facets of chromosomal synthesis. EOC produced a pronounced stickiness and a reduction in spiralization of the chromosomes in cells which are undergoing mitosis at the time of treatment. Sub-chromatid aberrations are induced at prophase and chromatid-type aberrations are induced at prophase and chromatid-type aberrations in G_2 and S (DNA-synthesising) cells. Although the evidence is not unequivocal, the results suggest that EOC, like x rays, can also induce chromosome-type aberrations in pre-synthesis, or G_1, cells. There was a tendency for aberrations to be localized to the nucleolar organising regions of the pair of metacentric chromosomes, but, in contrast to the findings of other workers, no evidence for a localization of aberrations to the centromere regions of the chromosomes was found. Mitotic delay during the first post-treatment cycle occurred mainly during the G_2 phase which is increased to approximately twice its normal duration. (auth)

13039 PHYSICAL OBSTRUCTIONS AND DISORDERS OF EYE IN THE ATOMIC-BOMB CASUALTIES. Shigenori Sugimoto. Nagasaki Igakkai Zasshi, 38: Suppl., 13-17(Dec. 1963). (In Japanese)

The physical effects of the atomic bomb are discussed and clinical observations on 18 cases with eye injuries as a result of the explosion in Hiroshima are reported. Physical data on shock wave pressure, thermal, and radiation effects, and protective properties of Japanese buildings are cited, and the amount of radiation the patients received from the bombing is calculated. A brief description of each patient's location and distance from the hypocenter, whether he received in- or outdoor exposure, his burns and other physical injuries, injuries to the eye, and other long-term effects on the eye are given in each case. It was concluded that many of the eye injuries were caused by the shock wave, and relatively fewer cases by direct exposure to radiation or heat. At 3-km distance from the hypocenter, where the shock pressure was below 2.29 kg/cm^2, some indoor casualties received exterior eye injuries, and there were two cases of cataract and one case of puncture in the blind spot of retina, these injuries being considered traceable to the percussion factor. Many indoor casualties escaped burn, but a case of severe burn among outdoor casualties at 2.1-km distance (thermal factor 8 cal/cm^2) was found. Acute radiation illness was prominent among those within 800 m (receiving 2000 R) and prevalent among those within 1650 m (receiving 18 to 68 R) despite the insulation effect of the buildings. Typical and progressive development of cataract occurred among those within 700 m (receiving 3000 R), and one case of loss of transparency of eye lens in the posterior zone occurred in an outdoor casualty 12 yr later, who was within 950 m (24 R). In some cases radiation is considered directly responsible for the loss of transparency of the lens or as a precipitating factor of senile cataract. (BBB)

13040 HEMOPOIESIS AND NUCLEIC ACID METABOLISM. REPORT IV. EFFECT OF RADIATION ON HEMATOPOIESIS WITH SPECIAL REFERENCE TO DNA SYNTHESIS OF BONE MARROW CELLS AS MEASURED BY INCORPORATION OF FORMATE-^{14}C. Shigeru Shirakawa (Kyoto Univ.). Naika Hokan, 10: 141-55(Mar. 20, 1963).

Suspensions of rabbit bone marrow cells were irradiated with doses ranging from 500 to 5000 R of ^{60}Co γ rays. Irradiation with 3000 R depressed the incorporation of formate-^{14}C into DNA thymine, whereas that into RNA purine showed only a slight decrease. Incorporation of formate-^{14}C was studied in the suspensions of bone marrow cells obtained from rabbits irradiated with a sublethal dose (500 R) of x rays. By 24 hr after irradiation the formate incorporation into DNA thymine was decreased. Three days after the irradiation there was a tendency to recovery, but there still remained a slight decrease. Five and 7 days after irradiation the formate incorporation was restored completely to normal. A DNA-^{14}C labeling study of bone marrow and peripheral leukocytes in guinea pigs irradiated with a sublethal dose (180 R) of ^{60}Co γ rays was carried out. In this experiment 3 hr after irradiation formate-^{14}C was administered. DNA thymine-^{14}C sp act. of bone marrow in the irradiated group was decreased at 8 and 24 hr as compared with that in the normal. However, the sp act. showed a tendency to increase at 2 to 4 days, suggesting a relative early recovery of the overall capacity to synthesize DNA or ability of the bone marrow to proliferate after sublethal irradiation. In addition, the incorporation of formate-^{14}C into nucleic acid bases in the spleen and bone marrow of the mice treated with isologous bone marrow transplantation after lethal irradiation with ^{60}Co γ rays was investigated. It was shown that the transplantation rapidly improved the hematopoiesis which had been depressed by the lethal irradiation doses (900 R) used. (BBB)

13041 RELATIVE BIOLOGICAL EFFECTIVENESS OF 592-Mev PROTONS ON MICE. J. Baarli (CERN, Geneva) and P. Bonet-Maury. Nature, 205: 361-4(Jan. 23, 1965).

The RBE of high-energy protons was investigated by exposing mice in the external proton beam of the CERN 600-Mev synchrocyclotron. Male mice, 57 days old, of pure strain (C57B66), weighing on the average 22.4 ± 0.5 g, were exposed. Six mice were exposed to doses of 600, 700, 800, 900, and 1000 Rads. After irradiation, the irradiated and control mice were kept under the same conditions and the following parameters recorded: mortality statistics (LD_{50} and median survival time); weight of the animals; weight of organs sensitive to radiation: spleen, thymus, testicles; hematological tests; white and red cell counts and differential white cell counts. The results confirmed that the RBE of near relativistic protons depends mainly on their linear energy transfer (LET) values. (P.C.H.)

13042 EFFECTS OF X-RAY PRE-IRRADIATION OF THE ABDOMEN ON ONSET OF YOSHIDA ASCITES SARCOMA IN RATS. E. Stutz and U. Reincke (Universitat, Freiburg i. B.). Naturwissenschaften, 51: 514(1964). (In German)

The effect of x-ray pre-irradiation on the abdomen on the onset of sarcoma in rats was studied by exposing male and female rats to 320 r 1, 2, 4, 8, 16, 24, and 32 days before injection of Yoshida ascites sarcoma cells. The percentage of sarcoma onsets and liver metastases were determined and the results tabulated. The results showed that the highest percentage occurred when the irradiation took place 4 days before the injection. The percentage of onsets was less than had occurred under whole-body irradiation. (J.S.R.)

13043 DEGENERATIVE CHANGES IN THE PELVIC GANGLIA FOLLOWING BETATRON IRRADIATION. Louis P. Bozzetti and N. A. Janovski (Columbia Presbyterian Medical Center, New York). Neurology, 13: 788-92(Sept. 1963).

A case is presented illustrating the degenerative changes that occur in the pelvic ganglia following betatron therapeutic irradiation procedures. For an invasive squamous-cell carcinoma of the cervix the patient received external irradiation over a five-week period, with a total tumor dose of 5000 R. Five months later, a total exenteration with ileal conduit and sigmoid colostomy was performed, but postoperatively a right lower lobe pneumonia developed terminating on the 17th postoperative day with death. Histologic study of the uterocervical ganglia showed crenation of the nuclei, moderate amount of lipochrome deposition in the cytoplasm, moderate margination of Nissl substance, and massive infiltration of the interstitial and perineural tissue with inflammatory cells. A relative in-

crease in the amount of Nissl substance present was also seen. Massive subanophilic granules were seen diffusely scattered in the cytoplasm of almost all ganglion cells; these granules were not present in Schwann cells. As expected, there was an increased amount of collagen fibers and reticulum fibers in the interstitial and perineural connective tissue, and proliferation of spindle-shaped Schwann cells. Another evidence of cellular degeneration was the finding of PAS-positive, diastase-resistant granules in the cytoplasm of ganglion cells, suggesting early mucoid degeneration. The slight deposition of sulfated polysaccharides, as revealed by the Gomori aldehyde fuchsin stain, further complemented the overall picture of cellular breakdown. The capillaries as well as arterioles and large vessels showed perivascular fibrosis and degeneration of the media and intima, as evidenced by breakdown of elastic fibers and deposition of sulfated mucopolysaccharides. A summary of the histochemical investigations is tabulated. The findings demonstrate the vulnerability of the ganglion cells and associated nerves to this specific type of irradiation. (BBB)

13044 A STUDY OF BONE MARROW IN X-RAY DOSIMETRY AS TO A CONSIDERATION OF DOSE DISTRIBUTION ACCORDING TO ITS STRUCTURAL PHASE. Masatoshi Sakka and Kazuhisa Haruyama (Tokyo Medical and Dental Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 98-101(May 25, 1962).

It is pointed out that in measuring the absorbed dose of irradiated bone marrow importance should be placed on the volume of marrow substance surrounding the trabeculae of bone. Highest ionization is produced in this area within the bone marrow, because bony substance of higher atomic number contributes relatively more ionization than the less dense substance located a distance from the trabeculae. For practical purposes of dosimetry of marrow irradiated with soft x rays (about 50 kev or less), it is suggested that it is sufficient to consider this volume as a zone surrounding bony trabeculae to be of 10 μ thickness. Attempts were made to evaluate more closely this relation by studies of histological sections of ribs, sternal bone, lumbal vertebrae, and femoral bones of normal men. The bones were photographed and printed enlarged 24 times in dia. The following measurements were made: (a) Area of trabeculae in a unit subsection of bone preparation; (b) Area of the marrow substance surrounding (and within 10 μ from) bony trabeculae; (c) Area of the marrow substance more than 10 μ distant from the bony trabeculae. Hence area of unit section: $S = \Sigma A + \Sigma B + C$. Measured values are shown in tables. Under the assumption that ionizations produced in the area surrounding the trabeculae up to 10 μ are twice those in other areas, the ionizations in infants' bone marrow would be increased 6%, and 2.4% in the age group of above 11, as compared with the assumption that the ionizations are elaborated evenly within bone marrow. (BBB)

13045 EFFECTS OF COLLOIDAL RADIOACTIVE GOLD ON YOSHIDA ASCITES TUMOR CELLS. PART 2. INHIBITION OF MITOSIS, CHANGES IN THE RELATIVE MITOTIC CELLS, AND EFFECTS OF RESTING STAGE OF CELLS AFTER INJECTION. Takeo Mimori (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 1109-24(Jan. 25, 1963). (In Japanese)

To study the effects of ^{198}Au on Yoshida ascites tumor cells, ^{198}Au in doses 2.0 to 0.3 mC were intraperitoneally injected in rats. After injection, ascitic fluid was withdrawn at intervals and stained with Giemsa stain. Mitotic cells per 1000 tumor cells (mitotic index), the relative proportions of the phases of mitosis, and abnormal mitosis were determined in each sample. Morphologic changes of resting stage cells were also examined. The effect of ^{198}Au on mitotic index (MI) was describable in four stages: rapid decrease of MI in the 2nd hr after injection; gradual recovery of MI in the next 24 hr after injection; decrease of MI on the 48th hr after injection; and increase of MI from 96 to 120th hr after injection. During the decreasing stage of MI, a decrease of early prophase figures and an increase of anaphase-telophase figures were recognized. Incidence of mitotic abnormalities, such as chromosomal bridges and fragmentation, increased in proportion to the injected radioactivity. Sticky bridges in anaphase-telophase figures and appearance of cells containing daughter nuclei were especially noted. (BBB)

13046 CRITERION OF BLOOD CHANGES OVER LONG OBSERVATION PERIODS. I. TESTING BY PARAMETERS ALPHA AND BETA. Nobuo Yamashita and Fumihiko Hoshino (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1483-7(Mar. 1964). (In Japanese)

A method was devised to correct for the so-called error factors in blood counts, for evaluating radiation exposure, with parameters α and β. Hematologic changes in peripheral blood of 60 healthy employees engaging in radiologic research were observed for about 5 yr and the parameters α and β were calculated. These parameters were defined by the empirical formula $y = at + b$ and by two equations: $\alpha = a$; and $\beta = at + b$ where t = time of observation. The empirical formula values were calculated by the least square law from graphs of times of observation plotted as the abscissa (t), and blood counts plotted as the ordinate (y). With parameter α, the white blood cell change was less than 100 per mm^3 monthly, red blood cell change was less than 3×10^4 per mm^3 monthly, and hemoglobin change was less than 0.80% monthly. With parameter β, white blood cell count was between 4000 to 9000 per mm^3, red blood cell count was between 400×10^4 to 550×10^4 per mm^3, and hemoglobin was between 70 and 110%. All persons tested failed to show any clinical signs of hematologic injury, therefore, these values probably are within the normal limits. (BBB)

13047 RADIATION THERAPY AND ITS RELATION TO THE OCCURRENCE OF ANTIBIOTIC-RESISTANT STRAINS IN THE INTESTINAL BACTERIA. Koji Takakura, Tadayoshi Shoji, Junko Okano, Katuo Ando, Tashio Hayashi, Masato Gomibuchi, and Yoshio Matumura (Nippon Medical School and Japan Red Cross Central Hospital Cancer Research Center, Tokyo). Nippon Ika Daigaku Zasshi, 29: 64-9(1962). (In Japanese)

In an effort to elucidate factors which induce or inhibit antibiotic-resistant strains in intestinal bacteria, various tests using chemical agents affecting this phenomenon are reported. The role of radiation as a possible factor in the development of resistant strains was studied. Stool samples from 38 cancer patients were tested on a culture medium containing streptomycin, chloramphenicol, or tetracycline (concentration 100 μg/ml). Possible correlations between radiotherapy with ^{60}Co γ rays or radium and the occurrence of the resistant strains were examined for each kind of therapy and for each antibiotic. The fact that some test patients had received antibiotic treatment tended to complicate the picture. However, this did not influence significantly the interpretation of the results which showed that there was no significant difference in the development of the resistant strains between those receiving and those not receiving radiation therapy. The difference was also insignificant when one kind of therapy or of the antibiotic combination was examined separately. (BBB)

13048 EFFECTS OF ^{32}P UPON THE TESTIS OF FOWL. Shiichi Nishida, Koshi Mochizuki, and Toshiro Shioda (Tokyo Univ.). Nippon Juigaku Zasshi, 26: 141-6 (June 1964). (In Japanese)

The testis of fowl treated with ^{32}P were studied histologically and cytologically. Immature and adult White Leghorn chickens were given intraperitoneal injections of ^{32}P (0.5 to 10 μC/g). A dose of 5 μC/g had a lethal effect on germ cells in the adult bird, causing a significant decrease in testis size. Histologically, the tubules decreased in diameter, the germ cells became irregular in arrangement, and spermatozoa and spermatids disappeared nearly completely. No vacuolation was observed in the germ cells and mitotic figures were rare, but numerous karyolytic and pyknotic figures were present. In adult chickens, some tubules of the testis had decreased in diameter 30 days after injection of ^{32}P (0.6 μC/g). In such tubules, almost

all germinal epithelia were of a single layer, consisting of spermatogonia and Sertoli cells only. Some other tubules, however, had stratified germinal epithelia containing mitotic secondary spermatocytes. This was considered as evidence of recovery. In adult chickens observed 10 days after administration of 0.5 μC/g of ^{32}P the germinal epithelium was single-layered, and mitotic cells were very few among the spermatogonia. On the 20th day, mitosis appeared among the spermatogonia. In adult chickens injected with 0.5 μC/g of ^{32}P, many abnormal mitotic figures were observed in the testes 30 to 45 days after injection. These figures decreased in number with time after injection. Giant cells appeared in the testes by the end of the 2nd month and vacuolation in germ cells within one month after injection. Thus there are age and dose differences in the testis response of chickens to ^{32}P. (TCO)

13049 EXPERIMENTAL STUDIES ON THE METABOLISM OF FOLIC ACID AND CITROVORUM FACTOR. III. FOLIC ACID LOADING TESTS IN DOGS TREATED WITH AMINOPTERIN, CARBON TETRACHLORIDE, VENESECTION, AND X RAY. Hidenori Sotobayashi (Kyoto Univ.). Nippon Ketsueki Gakkai Zasshi, 25: 148-58(Apr. 1962).

The effects of these agents on changes in the concentrations of folic acid (FA) and citrovorum factor (CF) in the blood and urine were observed in dogs. Total-body x irradiation at doses of 500 R were used and FA loading tests were carried out one week before and 45 hr after irradiation. Hematologic findings showed decreases in reticulocyte count, white cell count, circulating blood volume, and count of nucleated cells in the bone marrow. At loading tests after irradiation, blood concentrations and urinary excretions of FA were more increased in the earlier period and more decreased in the later period as compared with those before irradiation. Consequently, the extravascular uptake was decreased in one dog, slightly decreased in another dog, and changes in the blood concentrations and urinary excretions of CF were decreased in both dogs tested. It is concluded that the decrease in the urinary excretion of CF after irradiation might be attributed to the decrease in the activities of enzymes. The fact that the extravascular uptake of FA was decreased in one dog but unaffected in the other suggests that the amount of FA which is taken up directly into the bone marrow at the loading test is only a small part of the dose. The doses of FA were 150 μg per kg of body weight, intravenously. After administration of aminopterin the extravascular uptake of FA and the urinary excretion of CF were decreased. After a long period of administration of carbon tetrachloride the extravascular uptake of FA and the urinary excretion of CF were decreased. After chronic bleeding, the extravascular uptake of FA was either slightly increased or not increased, and the urinary excretion of CF was slightly decreased. Liver function appears to be the greatest factor influencing the loading test of FA, and under normal liver function the storage of FA in the body can be deduced, though indirectly, from the uptake into the liver. The kidney affects the estimation of body stores of FA but the influence of the kidney may be eliminated to some degree by considering the relation between the blood concentration and the urinary excretion of FA. It is not clear, however, whether the decrease in the urinary excretion of CF can be attributed to the decrease in the conversion of FA to CF or to the increase in the demand for CF. (BBB)

13050 RADIATION FIBROSIS OF THE LUNG. Hisao Yamashita (Keio Univ., Japan) and Tetsuya Nagase. Nippon Kyobu Rinsho, 23: 227-40(Apr. 1964). (In Japanese)

Pneumonitis and fibrosis of the lung caused by radiation were studied and are discussed. Doses above 1000 R in the lung field sometimes cause radiation pneumonitis 1 or 2 months after irradiation. With increasing dosage, the incidence becomes larger, for example, 30% to 3000 R and 50% to 5000 R. The subjective symptoms, which are markedly different from person to person and are varied, are mainly coughing and chest pain, and in serious cases are accompanied by fever and dyspnea. On the x-ray film, the ill-defined, mottled shadow, which shows different densities, but no nodule within it, is recognized. In 3 or 4 months, an x-ray film reveals shadow shrinkage and increased density, which suggests scar-formation, namely, fibrosis of the lung. On the x-ray film of the fibrosis, a concave triangle of increased density is observed, which is, in most cases, homogeneous and sometimes forms strands, and the thickening and traction of pleura are frequently seen. On the histological examination, the hyaline degeneration of epithelium and vasoendothelium, the infiltration of cells, and the accumulation of exudate are mainly recognized. In the differential diagnosis, the recurrence or metastasis of cancers and tuberculosis must be discriminated. When it is erroneously diagnosed and treated, the symptoms of the fibrosis are aggravated and sometimes the patients life is exposed to danger. Bronchography is useful to diagnose correctly, and in radiation pneumonitis it shows the same findings as the bronchoectasis. The use of adrenocortical hormones together with antibiotics is effective as treatment. (NSA of Japan)

13051 RELATIONS BETWEEN THE RETICULOENDOTHELIAL SYSTEM, TUMORS, AND X RAYS. PART I. Masatada Tanabe (Medical Okayama Univ., Japan). Okayama Igakkai Zasshi, 75: 959-64(Oct. 1963). (In Japanese)

The interrelations between the function of the reticuloendothelial system (RES), tumor growth and metastasis, and ionizing radiation were studied in rats. Yoshida sarcoma cells were implanted intramuscularly in the thigh of the rats, in which blockade of the RES was performed by injection of India ink. RES function was transiently impaired on account of phagocytosis of the India ink particles (colloidal carbon). When small amounts of the ink were injected, tumor growth was not appreciably affected despite suppression of RES activity. With larger amounts of India ink, tumor growth was accelerated, the reaction of the stromal cells to invading tumor cells being diminished. Under these conditions fewer RES cells were present in the developing tumors. The results are discussed in relation to previous studies with other types of tumor cells, the growth of which was affected by RES blockade. (BBB)

13052 RELATIONS BETWEEN THE RETICULOENDOTHELIAL SYSTEM, TUMORS, AND X RAYS. PART II. Masatada Tanabe (Okayama Univ., Japan). Okayama Igakkai Zasshi, 75: 965-79(Oct. 1963). (In Japanese)

To investigate the influence of radiation on the activity of the reticuloendothelial system (RES), as it affects tumor cell growth and metastasis, studies were conducted in rats implanted with Yoshida sarcoma cells. The rats were x irradiated with daily doses of 600 R over five days, totaling 3000 R, given to the thigh region, where the sarcoma cells were subsequently implanted intramuscularly at various intervals. Tumor growth, metastasis, and survival times were then determined. Compared with the unirradiated controls, tumor growth was inhibited. The greatest degree of inhibition was noted when tumor cells were implanted one day after irradiation, while less inhibition occurred when tumor implants were made 10 days later and least with implants made 30 days after irradiation. Survival rates were increased in the same order of implantation delay after irradiation. A stronger stromal reaction and increased numbers of RES cells were seen in the preirradiated tumor beds than in unirradiated tissue. In other experiments the developing tumors were irradiated with 300 R/day for ten days, totaling 3000 R, and tumor size changes and survival times were recorded. The results showed that when RES blockade was induced before irradiation, thus reducing RES function, the effectiveness of irradiation against tumor growth and metastasis was diminished. It is suggested that irradiation of the RES after its activity has been enhanced might have a favorable effect on inhibiting tumor development. (BBB)

13053 HISTOLOGIC AND PHYSIOLOGIC ALTERATIONS IN THE CANINE PAROTID GLAND FOLLOWING THE PREIRRADIATION RETROGRADE INSTILLATION OF 2-MERCAPTO-ETHYLAMINE (CYSTEAMINE). Theodore

R. Kielts, James R. Hayward, and Gerald H. Bonnette (Univ. of Michigan, Ann Arbor). Oral Surg., Oral Med., Oral Pathol., 18: 742-51(Dec. 1964).

A possible means of protecting the salivary glands from injury during radiotherapy directed to the head and neck region was investigated. The parotid ducts of dogs were cannulated bilaterally, and the volumetric response of parotid glands to intravenous pilocarpine stimulation was then determined. The right parotid gland of each test animal was injected with 2-mercaptoethylamine (cystamine). The test animals were bilaterally exposed to 250-kv x rays in single total doses varying from 500 R to 1500 R. After a recovery period of three weeks the volumetric response of the parotid glands to pilocarpine stimulation was determined again, and the parotid glands were submitted to histologic study. All irradiated test animals and nonirradiated control animals showed increased response to repeated intravenous pilocarpine salivary stimulation. Preirradiation injection of cystamine and physiologic saline solution did not significantly alter the function or histologic appearance of irradiated parotid glands. There was no apparent correlation between histologic findings and response to pilocarpine stimulation in irradiated parotid glands. The loss of serous acinar pattern in the canine parotid gland occurred after a single dose of 1500 R, but in spite of this loss the salivary response to pilocarpine was significantly increased. The following decreasing order of sensitivity to irradiation of the various glandular structures was observed: mucous acini, serous acini, intralobular ductal epithelium, and interlobular ductal epithelium. There was a consistent loss of mucous acini following irradiation doses between 500 and 750 R. It is proposed that further studies relating to protection of major salivary structures from irradiation changes should be directed at protecting ductal epithelium during the course of treatment with high-energy irradiation. (BBB)

13054 CHANGES IN GLYCOGEN, LIPIDS, AND NUCLEIC ACIDS IN THE LIVER DURING ACUTE POSTRADIATION DISEASE IN RATS. Zbigniew Bankowski, Barbara Biczowa, Michal Gorski, Stefan Krus, Zdzislaw Lewicki, Zygmunt Ruszczewski, and Stefan Starzynski (Experimental Pathology Research Center, Polish Academy of Science, Warsaw). Patol. Polska, 13: 325-36(July–Sept. 1962). (In Polish)

Histochemical and chemical experiments were performed on 40 Wistar rats which were divided into two groups. The first group, comprising 30 rats, was submitted to x irradiation of the whole body with a dose of 900 R, while the second group of 10 rats served as controls. The animals were decapitated 3, 6, and 24 hr, and 2, 3, 4, 5, 6, 7, and 8 days after irradiation. Twelve hours before sacrifice the animals were kept in a fasting condition. Glycogen in the liver was assayed chemically and histochemically, lipids were estimated by staining with Sudan III, and nucleic acids were assayed with the usual routine methods. In addition, sections were stained with hematoxylin-eosin. Marked hepatic depletion of glycogen was found during the peak of clinical symptoms of acute postradiation disease. Fatty degeneration of the liver cells appeared at the same time. Changes in nucleic acids preceded the appearance of fatty degeneration and glycogen depletion. The observed changes are discussed in terms of manifestations of hepatic damage, as seen histologically. With repair of the radiation-injured liver cells, the return of glycogen and cholesterol levels to normal began on about the 6th postirradiation day. Cholesterol levels rose to normal or above by the 8th day, while glycogen levels were still slightly below normal at this time. The most precipitous fall of both these liver constituents occurred within the first six hours after irradiation. (BBB)

13055 OSMOTIC EXCHANGE OF LEUKOCYTES IN PATIENTS WITH MALIGNANT TUMORS TREATED WITH X RAYS. Maria Bicz-Ciencizlowa (Radiological Clinic, Medical Academy, Krakow). Postepy Hig. Med. Doswiadczalnej, 17: 223-33(Jan-Apr. 1963). (In Polish)

Studies were conducted on the osmotic fragility of leukocytes in 11 patients with malignant tumors being treated with 180 to 200-kv x rays. This represented an attempt to develop another hematologic index to evaluate the efficacy of radiotherapy. The leukocytes were examined microscopically for injury after immersion in 0.20% NaCl solution. These tests were conducted every 1/2 hr for 3 hr after irradiation, then at weekly intervals for up to four weeks. Results are shown for lymphocytes and monocytes. In all cases a change was noted in the osmotic fragility of the cells after irradiation. The percentage of cells damaged by 0.20% NaCl solution increased progressively up to the third hour after irradiation. Similar changes were noted for lymphocytes and monocytes. These changes were noted in all cases although a decrease in the total circulating leukocyte count occurred in only one case, indicating that the osmotic test is a more sensitive index of leukocyte injury than the total count. The osmotic changes were noted before the cell count dropped below 3400. (BBB)

13056 RADIATION AND THE STRUCTURE OF BONE. F. W. Spiers and G. W. Reed (Univ. of Leeds, Eng.). Postgrad. Med. J., 40: 149-51(Mar. 1964).

Various aspects of dosimetry in bone receiving external radiation or radiation from incorporated radioisotopes are discussed. The physical consideration of this irradiation of bone is complex because (a) the increased radiation absorption in bone, compared with that in soft tissues, depends markedly on radiation energy, (b) the deposition of radioisotopes in bone is frequently very nonuniform and (c) the ionizing particles (secondary electrons released by x rays and α and β particles from radioisotopes) which distribute the radiation energy within bone, have ranges which are of the same order of magnitude as the dimensions of the microscopic structures of the bone anatomy. The distribution of the radiation dose within these structures has usually been obtained by calculation because physical measurements of dose over distances of a few tens of microns have not been possible. Bone surfaces and cylinders, impregnated with ^{90}Sr have been used to measure the dose over distances of up to 3 mm by means of thin discs of a plastic scintillator (100 to 300 μ thick) with electronic measurement of the scintillations emitted. This is possible because the ranges of the ^{90}Sr β particles are sufficiently large for a macroscopic experiment. This made it possible to test the correctness of the mathematical methods and obtain evidence of the radiation dose from this bone-seeker. An experimental determination of the dose to marrow was also made in a model of trabecular bone, in which plane marrow cavities of 500 μ thickness were sandwiched between plane trabeculae 125 μ thick containing ^{90}Sr. Because the radiation dose to active marrow depends on the dimensions of the marrow cavities in trabecular bone, attempts were made to measure by simple optical means the numbers and sizes of marrow cavities as seen in cut sections of various bones. It was thus possible from these results to calculate the fractions of space in trabecular bone occupied by marrow and by bone. The results obtained were used in the determination of the dose to bone marrow in diagnostic x-ray procedures. An apparatus to select a fixed energy band from an x-ray beam and measure the effective atomic number of cortical bone on the basis of this relation is considered. Certain radioisotopes emit monoenergetic radiations which make it possible to make similar measurements on bones in vivo as well as in vitro. Measurements on cortical bone investigated gave the effective atomic number as 13.7 compared with the value 13.8 determined in earlier experiments. (BBB)

13057 THE FUTURE OF INFANTS IRRADIATED IN UTERO: A STUDY OF A SURVEY BASED ON 5353 OBSERVATIONS. P. Magnin. Presse Med., 70: 1199-1202 (May 19, 1963). (In French)

Data were collected on 5353 infants irradiated in utero during obstetric diagnostic radiology, and a detailed study was made on 375. Of these, 187 received 0.15 to 0.30 R in utero, four received 0.25 to 0.40 R, 136 received 0.50 to 0.70 R, 47 received 0.70 R, and one received 0.90 to 1.0 R. Only one fetus was irradiated before the 6th month. In the

6th month 16 fetuses were irradiated; 7th month, 34; 8th month, 105; and 9th month, 219. Ninety-five percent of the total x-ray exposure was received in the last three months of gestation. A control group was established in which an infant not irradiated in utero was paired with one that was. Over a period of nine years, 319 irradiated and 227 control children died. Nine out of 10 women who had twins were x rayed during pregnancy. Seventy of the irradiated twins died, while only 7 of the control group died. Malformations, often accompanied by an excess of amniotic fluid (usually entailing a radiological examination), were present in 37 of the irradiated children and 24 of the controls. Obstetric trauma was the cause of death in 20 irradiated infants but only 10 control infants; this difference was not caused by irradiation, but was a result of pelvic anomalies that prompted diagnostic irradiation. If the cases of twins, there was no statistically significant difference in the number of deaths in the irradiated and control groups. No leukemias were noted in either group. It was concluded on the basis of the available evidence that there is little danger to the fetus of diagnostic irradiation during the last two months of gestation. (TCO)

13058 DELAYED INJURIES OF THE CENTRAL NERVOUS SYSTEM AFTER CRANIAL IRRADIATION. J. Cervos-Navarro (Universitat, Bonn). Proc. European Regional Conf. Electron Microscopy, 3rd, Prague, 1963, 267-8(1964). (In German)

Three groups of 6 rabbits were each cranially irradiated with 1500, 2000, and 2500 R from a telecobalt unit, betatron, and x rays. At 6 and 12 months after irradiation sections from the parietal region were studied with the electron microscope. The tissue changes found were not directly related to the type of irradiation. Granular elements were much more prevalent in the nuclei and cytoplasms of irradiated animals than in unirradiated animals. The golgi zones were increased in size and in number of cells present. In many of the nerve cells the nucleolenema was discernible apart from the karyoplasm, so that the nuclear bodies could be identified only by a few chromocenters. Many of the ribosomes were situated in the cytoplasm. There were many laminar osmophilic bodies in the cytoplasm of both light and dark cells. They varied in size, while the cytoplasmic structures interspersed between them showed no evidence of degeneration. Most of the glial cells were swollen, and their usual structures were decreased in number. There were large numbers of giant mitochondria, and because of the increased size of the external chondrioplasm the cristae were shifted peripherally. The most striking and consistent finding was an extension of the basal membranes into the space that separates the endothelial from the astrocytic membrane. (BBB).

13059 HISTOCHEMICAL STUDIES ON THE EFFECT OF X IRRADIATION ON ACID DEOXYRIBONUCLEASE. A. Vorbrodt and Z. Dobrek (Inst. of Oncology, Giliwice, Poland). Radiobiol. Radiotherap., 3: 195-203(1962). (In German)

A histochemical study was made of the liver and spleen of mice 24 hr and three, five, and seven days after a single total-body x irradiation dose of 750 R. Parallel investigations were carried out on sham-irradiated animals. Acid deoxyribonuclease (DNase II), and for comparison the acid phosphatase (AcPase), were detected by means of histochemical methods. Already 24 hr after irradiation, the number of the phagocytic cells rich in DNase II and AcPase increases considerably in the spleen. These enzymes are localized in the cytoplasmic granules (lysosomes or phagosomes). In the same time the number and the size of lymphoid nodules diminishes. The lymphocytes and the lymphocytes and the lymphoblasts which are present in these nodules do not give positive reaction for the enzymes studied. In the liver of irradiated animals the reaction for DNase II and AcPase in phagosomes of the Kupffer cells considerably increases. It is concluded that the increase of DNase II activity in the phagocytic cells may be an enzymatic adaptation caused by the appearance of the free DNA liberated from the damaged lymphocytes. The increase of DNase II activity in the lymphatic organs of irradiated mice depends on two parallel phenomena: (1) the disappearance of the cells poor in this enzyme, which is the cause of the organ weight loss; and (2) increase in number of radioresistant cells (macrophages) rich in DNase II. These two factors explain the considerable increase of DNase II activity calculated in relation to organ weight or to the number of cells. Many cells in the red pulp of spleen and the parenchymal cells of the liver show the presence of lysosomes rich in AcPase, but poor in DNase II. Some of the Kupffer cells of irradiated animals show a very strong reaction in the phagosomes for DNase II and for AcPase as well. These phenomena indicate possible differences in the chemical structure of lysosomes in various cells. (BBB)

13060 RADIOBIOLOGY: CELL SENSITIVITY. Gloria Blake. Radiol. Technol., 35: 75-9(Sept. 1963).

Differential radiosensitivity of normal and malignant cells and of various types of normal cells is considered, with particular reference to experiments on cultured cells. One such experiment demonstrates that cell mitosis is arrested by various doses of radiation. A graph showing the number of surviving cells versus the dose of radiation gives a survival curve for the particular strain of cells and the type of radiation used. This curve can be used to predict the number of cells which will survive in a given colony from any given dose of radiation. After irradiation, when the cell attempts to divide for the first time, many unusual phenomena may be observed. Thus in an irradiated population of L cells, 40 hr after a dose of 5000 R, some chromosomes were seen to have changed in size or shape. This was caused by the joining of ends split by the radiation. However, in spite of their change in form, these chromosomes were still able to divide and form daughter chromatids, which explains the presence of genetic mutations induced by irradiation of the cell. Chromosomes in giant cells will increase in number. Although these cells do not mitose in a normal fashion, they may attempt to divide and form bridges. Or the cells may attempt to split in three ways; since there are not sufficient chromosomes to create three new cells, a tripolar spindle may be formed. Radiation damages a cell regardless of its mitotic phase, but the damage does not manifest itself until the G2 phase of the cycle. Damage occurs in the form of a block on the cell cycle, so that cell division may be delayed or synthesis of DNA may be reduced. In another experiment, animals were irradiated and given doses of carbon tetrachloride at several intervals between one and 257 days after the irradiation. It was shown that radiation damage to liver was the same at any point during this period, but no damage appeared until the cells attempted to divide. Thus the liver tissues were made more sensitive to radiation by increasing their mitotic rate. (BBB)

13061 NEWER ASPECTS IN CELLULAR RADIOSENSITIVITY. Anna Goldfeder (Dept. of Hospitals, New York and New York Univ., New York). Radiology, 84: 312-23 (Feb. 1965).

Experiments were designed to correlate structural with functional properties of cells for the purpose of defining the role they may play in cellular radiosensitivity. Three types of tissue were used for this study: a relatively slowly growing epithelial tumor, a rapidly growing spindle-cell tumor; and normal lymph nodes. All were indigenous to the same inbred strain of mice. The tissues were irradiated in situ with specific doses of x rays, excised at various intervals of time following exposure, and employed for electron microscopic and biochemical studies. Results indicated that the quantity and quality of cytoplasmic organelles, particularly those capable of oxidative phosphorylation such as mitochondria, play a significant role in cellular radiosensitivity. The difference in radiosensitivity between various cell types is explained by the dissimilarity in their cytoplasmic composition with regard to the quality and permeability of the membrane system. Acute cell death is the result of injury inflicted by irradiation on the bordering plasma membranes. The great radiosensitivity

of lymphocytes is attributed to the paucity of cytoplasmic organelles, particularly of mitochondria. Displacement of intracellular enzymes is one of the factors leading to distortion of cell function. (auth)

13062 ACTION OF TELECOBALT-60 ON BLADDER KINETICS (EXPERIMENTAL). A. Trabucco, F. Marquez, and B. Otamendi (Facultad de Medicina, Buenos Aires). Rev. Arg. Urol., 30: 11-50(Jan.-Aug. 1961). (In Spanish)

Attempts were made to find an explanation for disturbances in bladder kinetics after radiotherapy of carcinoma of the bladder, or other malignancies affecting it. Rats were exposed to the radiation of a telecobalt therapy unit, using a small field to cover a minimum volume to avoid a general reaction. The dose was 900 rad delivered in a single session, for the study of the reaction up to the first 24 hr, and in three sessions of 300 rad each in three days for longer periods of observations. Bladder contractions were studied by removing the organs and placing them in Tyrodes solution; acetylcholine was then added to the medium, and a record of the contractions taken. The solution was changed and, following the same procedure, adrenaline, prostigmine, and atropine were added. In other experiments, curare was added to the media or injected in the animals. The reactions observed could be divided in three periods during radiotherapy. The first consisted of hyperaction of the irradiated bladder to the presence of the acetylcholine and prostigmine. Histologic studies during this period showed edema of all the bladder tissue and desquamation of the epithelium with ulceration; this period lasted until the fifth day. In the second period bladder contractility began to equal that of the control animals, and histologically there was a beginning of epithelial restoration. However, some cellular abnormalities were seen, the muscle and the nervous elements showed distortion, hyalinization, and the initiation of the fibrotic changes. This period lasted about 30 days. In the third period the reaction to the drugs was slower and of low intensity, and the changes in the structures included regeneration of the epithelium and fibrosis in the other tissues. The explanation given for these results refers to the effects of radiation in producing three kinds of lesions in the bladder: those in the smooth muscle, those in the nervous elements, and those affecting the whole organ. (BBB)

13063 ATTEMPTS TO PREVENT THE SECONDARY SYNDROME OF HEMATOPOIETIC RADIOCHIMERAS BY IRRADIATION OF INCOMPATIBLE DONORS. J.-L. Amiel, G. Seman, M. Matsukura, and G. Mathe (Centre de Recherche Cancerologique et Radiopathologiques de l'Association Claude-Bernard, Hopital Saint-Louis, Paris and Institut Gustave-Roussy, Villejuif, Seine, France). Rev. Franc. Etudes Clin. Biol., 9: 974-7(1962). (In French)

F_1(DBA/2 × C57Bl6) mice irradiated with a dose of 500 R were injected with 10^7 bone marrow and 2.5×10^7 lymph node cells the same day from untreated C57Bl6 mice and 2.5×10^7 cells, either not x irradiated (control group) or subjected, 24 hr before, to a dose of 50, 100, 200, 300, 400, 500, 600, or 700 R. One group received only 10^7 marrow cells after irradiation. Control mice and mice receiving cells from donors irradiated with up to 200 R were all dead within 60 days. The respective median and average survival times were: control: 15 and 22.5 days; 50 R: 14.5 and 15 days; 100 R: 11 and 10.8 days; 200 R: 11.5 and 15.3 days. At 300 R, 15 of the 16 mice died within 60 days with a median survival of 23 days and an average survival of 25.1 days. At both 400 and 500 R, 13 of the 16 mice died within 60 days, with a median survival of 30 days and an average of 31.2 days. Of the 16 mice receiving cells from donors exposed to 600 R, 9 died before the 60th day, with 40 days median and average survival time. At 700 R, 7 of the 16 mice were dead within 60 days with a median survival time of 35 days and an average of 38.7 days. This dose was still capable of inducing a secondary syndrome in irradiated recipients. Of the group injected with only 10^7 marrow cells, only one out of 26 died before the 60th day. Mice injected with cells from donors irradiated with 400 R or more showed a marked increase in survival time over control animals. In a second, similar experiment F_1(AkR × C3H) mice were irradiated with 950 R and transfused with 2×10^7 marrow cells from F_1(C57Bl6 × DBA/2) mice either not prepared (control) or irradiated with 300, 400, 500, 600, or 700 R. In all the irradiated groups the percentage of survivors beyond the 100th day was below that of the control group. In the control group 10 of the 21 mice died within 20 days. More than half of those receiving transfusions from irradiated donors died within 20 days, the largest number (13 of 14) in the 600-R group. In a third experiment F_1(C57B16 × DBA/2) mice were irradiated with 950 R and received 10^6 marrow cells from isogenic donors either not treated (control) or irradiated with 400, 500, or 600 R. The amount 10^6 was used because it is the smallest bone marrow graft giving 100% restoration in isogenic recipients. Survival of mice beyond the 30th day was as follows: control: 11 of 11; 400 R: 10 of 14; 500 R: 6 of 10; 600 R: 2 of 10. The restorative value of an isogenic marrow graft from a donor irradiated with 600 R was almost nil. Pre-irradiation of a donor does not appear to diminish the incidence of the secondary syndrome in incompatible hematopoietic grafts. (BBB)

13064 RADIOINDUCED METABOLIC CHANGES AND LEUKEMIA. H. Langendorff, H.-J. Melching, M. Abe, and K. Shibata (Universitat, Freiburg i.B.). Rinsho Ketsueki, 5: 31-40(1964). (In German)

In mice which do not develop leukemia spontaneously, it is possible to produce leukemia by whole-body irradiation with 3 exposures of 150 R each, administered 4 days apart. The animals were observed over a period of 12 months. Of 100 mice, 38 died of thymic lymphatic leukemia with thymic tumors. One mouse died of a myelopoietic leukemia. Along with the increased leukemia incidence there was increased urinary excretion of xanthuric acid, with some, but much less of an increase in taurine excretion. This indicated decreased transformation of 3-hydroxykynurenine to 3-hydroxyanthranilic acid, and suggested also that one result of irradiation was to increase the amount of free tryptophan and its metabolites, and reduce the amount of this amino acid that was incorporated into proteins. It also may have been associated with inhibition of decarboxylase enzyme systems which utilize pyridoxal phosphate as a coenzyme. The effect on tryptophan metabolism seemed to be specific for kynureninase because there was no evidence of effect to reduce taurine excretion. The authors suggest that the increases in amounts of tryptophan and its metabolites observed after irradiation might be one factor that could be taken into account as an indication of the development of leukemia. (BBB)

13065 COSMIC RADIATION AND TUBERCULOSIS. IV. INFLUENCE OF COSMIC RADIATION ON TUBERCULOSIS AT HIGH ALTITUDE (3,130 M) AND AT SEA-LEVEL. Shan-yuan Wang. Sci. Sinica (Peking), 13: 61-80 (1964).

One thousand mice were injected intravenously at sea-level with 0.7 mg of tubercle bacilli H37Rv and afterwards divided into ten equal groups. Five groups were kept at sea-level and the other five groups were transported at Hsi Tai San (3,130 m). At sea-level as well as at 3,130 m one group was exposed to direct cosmic radiation in darkness, a second group was exposed to direct cosmic radiation and daylight with ultraviolet light. The other three groups were exposed to cosmic radiation under 1, 2, and 10 cm Pb, respectively. The experiment lasted 42 days. At 3,130 m the mice exposed to cosmic radiation under 10 cm Pb showed a significantly greater mean survival time and a significantly greater number of survivors than the mice exposed to direct cosmic radiation with or without daylight. This suggests that the penetrating showers of cosmic radiation were responsible for the effect. The mice kept at 3,130 m exposed to cosmic radiation under 10 cm Pb showed a significantly greater mean survival time than the mice kept at sea-level exposed to direct cosmic radiation, to cosmic radiation under 1, 2, and 10 cm Pb. The

results also showed that a decrease in lung lesions was associated with an increase in survival time and an enlargement of the spleen. At 3,130 m the female showed a significantly greater number of survivors than the male, while at sea-level no significant difference was observed. On the average the female showed a significantly greater number of survivors than the male. The beneficial effect of daylight with ultraviolet light was manifested in a lower maximum of mortality and in a significant decrease of lung and spleen lesions. (Sci. Abstr. China, Biol. Sci., 2: No. 3, 1964)

13066 EFFECTS OF X RAYS ON THE GROWTH, MATURATION, AND FERTILITY OF RATS IRRADIATED AT SEVENTH DAY AFTER BIRTH. IV. DEVELOPMENT OF THE OVARY. J. Chu and S. S. Lu (Academia Sinica, Shanghai). Shih Yen Sheng Wu Hsueh Pao, 8: 217-21(May 1963). (In Chinese)

Seven-day-old female rats were exposed to whole-body x irradiation at single doses from 200 to 400 R, and development of ovaries at later intervals was studied. In irradiated ovaries, the primordial oocytes in different developmental stages were very sensitive and disappeared in successive order, whereas the primary oocyte of the growing follicles seemed to be more resistant to radiation. The oocytes of some of these growing follicles continued to develop normally and produced the functional ova which would account for a short period of persistent fertility in irradiated mature females. No direct damage was found among the cells of the anovular follicles derived from the primary follicles in which the oocytes had been destroyed after irradiation. The radiosensitivity of the granulosa cells was higher than that of follicle cells in earlier stages of development. The relation between the stages of development of oocytes and their follicle cells and their radiosensitivity as well as their relative radiosensitivity are discussed. No apparent histologic alterations were found in the development of the interstitial tissue of the ovaries in irradiated animals. Huge corpora lutea, which were normal in histologic appearance, developed in ovaries irradiated with higher doses (400 R) of x rays. This may be related to the compensatory hypertrophy of the corpus luteum as a result of the decrease in the total number of corpora lutea in irradiated ovaries. Abnormally large, thin-walled, and vesicle-like follicles were also found in such ovaries. (TCO)

13067 EFFECTS OF X RAYS ON THE GROWTH, MATURATION, AND FERTILITY OF RATS IRRADIATED ON THE SEVENTH DAY AFTER BIRTH. V. DEVELOPMENT OF THE TESTIS. S. S. Lu and J. Chu (Inst. of Experimental Biology, Academia Sinica, Shanghai). Shih Yen Sheng Wu Hsueh Pao, 8: 222-9(May 1963). (In Chinese)

Seven-day old male rats were exposed to whole-body x irradiation at single doses of 300 and 400 R, and then killed at intervals ranging from 6 hr to 3 months after irradiation. The testes were removed, weighed immediately, and fixed in Helly's fluid. The diameter of the seminiferous tubules was measured and the numbers of the seminiferous tubules as seen in the cross-sections of the widest region of the testes were counted. The numbers of the type A, intermediate, and type B cells spermatogonia, necrotic cells, and cells in mitosis were also counted. These quantitative histologic studies showed that the reduced size of the testes observed in irradiated animals during development and in the adult animals was due to the irreparable radiation damage in the spermatogonia and the general inhibition of mitotic activity, resulting in the decrease in size and length of the seminiferous tubules as compared with those of normal animals. In some sections of irradiated testes the seminiferous tubules were completely devoid of germ cells. However, sterility of the irradiated animals was not entirely correlated to the number of these atrophic tubules. In a few cases the irradiated animals were fertile, irrespective of the fact that the number of seminiferous tubules with normal spermatogenesis was very low as compared with that of atrophic tubules. (BBB)

13068 EFFECTS OF IONIZING RADIATION ON THE IMMUNE PROCESS. H. St. Stender (Universität, Marburg, Ger.). Sitzber. Ges. Befoerder. Ges. Naturw. Marburg, 85: 19-38(1963). (In German)

A bibliographic study was made of the effects of radiation on immune reactions in mammals. Local irradiation leads to an increased antibody formation. Whole-body irradiation with doses over 100 R inhibits the antibody production increasingly with the radiation dose. The different periods of antibody formation possess various radiosensitivities. An early phase is especially radiosensitive. It was assumed that the activation of the lymphoid cells and the processes thereby occurring in the cells represents at least a part of this sensitive phase. The radioresistance of the lymphoreticular tissues was significantly increased by preliminary treatment with antigens of different specificity and non-specific irritants. These materials activate the cells of the lymphoid reticulum which, in the active state, are less radiosensitive than in the quiescent state. The different radiosensitivity of the individual sections of the interphase before and after the beginning of DNA synthesis was referred to for clarification. The administration of these substances a short time after irradiation with average doses is connected with a decrease of the radiation damage to the antibody formation. The increased radioresistance of pre-treated tissues is also detectable in the transplantation of spleen tissue to highly irradiated homologous animals. One of the determining factors for the intensity of the antibody is the number of active cells of the lymphoreticular tissues at the time of the presence of the effective antigens. (tr-auth)

13069 OCCUPATIONAL DERMATOLOGY: CURRENT PROBLEMS. Donald J. Birmingham (Public Health Service, Cincinnati). Skin, 3: 38-42(Feb. 1964).

Recent reports of skin diseases in workers as a result of exposure to new chemical and physical agents are discussed. A variety of new substances and processes have become conspicuous because of their dermal injury properties. Sometimes the clinical effects seen may be new and unusual; however, sometimes only the manner of contact is different. Some of the new chemicals reported to have caused occupational dermatoses include a substituted derivative of paraphenylenediamine used in color photographic development, tetrachlorsalicylanilide, a germicide incorporated in an industrial soap, and two psoralen compounds present in diseased celery which produced phototoxic blisters among celery harvesters. Among the physical agents, radiant energy in its many forms constitutes the cause in a number of occupational dermatoses. Skin hazards are present in the production of fissionable materials for industrial use, production of radioisotopes and their use in research medicine, and in industry in the miscellaneous uses of x-ray machines and diffraction apparatus. At least 10 cases of radiation injury from x-ray diffraction machines have been seen within the past few years. Some have occurred among technical personnel who were well aware of the harmful potential of the x-ray beam in a diffraction apparatus. A new physical hazard involves the plasma torch operation, used for cutting or spraying metals at temperatures up to 60,000°F. Workmen handling this apparatus and all others in the vicinity are exposed to intense noise and electromagnetic emissions from the arc generated by the plasma jet apparatus. The noise can be controlled by proper devices, and flash burns of the eyes can be averted by proper filters in safety glasses and by wearing hoods during operation. At present there is some uncertainty about the radiation hazards associated with the plasma jet, but it emits radiation in the range of about 10 to 100,000 Å, which would include x rays, uv, infrared, and visible light. In addition to the radiant energy exposure, ozone, oxides of nitrogen, and vapors of metals and refractories never before vaporized are produced and may entail a hazard. (BBB)

13070 BEHAVIOR OF ELECTROLYTES AND ENERGY-PRODUCING PROCESSES IN THE SPLEEN OF NORMAL AND ADRENALECTOMIZED RATS AFTER WHOLE-BODY

IRRADIATION. Heinz Karl Parchwitz, Elisabeth Wittekindt, and Wolfgang Wittekindt (Universitat, Munich). Strahlentherapie, 126: 94-104(Jan. 1965). (In German)

The influence of x irradiation upon the behavior of the endogenous respiration and the anaerobic glycolysis as well as upon the concentration and the active transport of potassium and sodium was investigated using histological spleen sections of normal and adrenalectomized male rats. The values were determined 0, 1, 2, and 24 hrs after total body irradiation with 50, 500, 5000, and 50,000 R. Compared to the controls, the potassium content was significantly decreased in the non-adrenalectomized animals that irradiation with doses above 500 R and an interval of 24 hours after irradiation. The sodium content had increased. A complete compensation could be observed in single cases only. Only larger doses and longer intervals after irradiation influenced oxygen uptake and anaerobic glycolysis. Adrenalectomy caused a considerable increase of the potassium loss, which was compensated partially by an increase of sodium; furthermore, a greater reduction of the endogenous respiration and the anaerobic glycolysis were observed. This was observed in the non-irradiated controls as well as with lower doses and shorter intervals after irradiation. The results suggest, that in spite of the almost unidirectional influence of ionizing radiation and adrenalectomy upon the investigated metabolic processes, the same effect is obtained by different mechanisms. (auth)

13071 ON THE FUNCTIONAL RADIATION SENSITIVITY OF THE LIVER. Hermann Birzle and Eckhard Franzius (Universitat, Freiburg i. B.). Strahlentherapie, 126: 119-31(Jan. 1965). (In German)

After reviewing the literature, observations concerning liver function disturbances after specific irradiation of the liver in animal experiments are described. Excretory liver function was determined with the Bromsulfalein test in rabbits after single as well as after fractional x-ray depth irradiation of the liver. Using medium doses, the liver showed a small but distinct retardation in excretory function. 50% inactivation values of the dye elimination were used for characterizing these changes and were compared with values obtained by different liver damaging techniques. The importance of such a determination in elucidating radiation damage in the liver is discussed, and the possibility of a longer lasting latent damage to liver function is pointed out. (auth)

13072 THE EFFECT OF CHRONIC ^{60}Co GAMMA IRRADIATION ON THE TESTES OF THE ALBINO RAT. II. EFFECTS ON THE PHOSPHORUS AND NITROGEN CONTENT. Chandra K. Parekh and Sidney O. Brown (Cornell Univ., Ithaca, N. Y.). Texas J. Sci., 16: 376-82(Sept. 1964).

Male weanling Holtzman albino rats were chronically exposed to γ radiation for 10 days (100 R), 20 days (200 R), 30 days (300 R), 40 days (400 R), or 50 days (500 R). Total nitrogen in the testis of the control and the irradiated animals varied only slightly, the calculated protein content (total nitrogen × 6.25 = total protein) varying between 10.01 and 12.32% in both groups of testes. However, when the per cent total nitrogen was converted to total nitrogen content of the whole testis, the differences were accentuated due to the differences in testes weights between irradiated and nonirradiated animals, which were significant for groups receiving 300 R or more total-body dose. Total phosphorus (mg/100 g tissue) was higher at the initiation of the experiment, but with increasing time and age of the animal it progressively decreased. However, when total phosphorus was expressed as per cent of the testis weight, it increased with age. In the irradiated groups the decline of total phosphorus (mg/100 g tissue) was slower than that of the control group. Since the effect of age was complicated by the treatment effect, a regression analysis was performed on the difference in the total phosphorus content between control and irradiated animals. In the regression equation $Y = a + bx$, where Y represents the total phosphorus content difference (control-irradiated) and x represents the irradiation doses, the regression $b_{y.x} = -6.06$, which is significant. The negative regression indicated that the total phosphorus content was higher in the irradiated animals than in the control animal at the same age. Thus there was a slower rate of decline of the phosphorus-containing compounds in the irradiated organs. The reduced rate with respect to time and dose may be the result of reduced mitotic activity of the testis with the accumulation of total body dose. The decreased rate of disappearance of phosphorus in the irradiated testis with increasing dose may be due to the increased ATPase activity and could also be due to reduced phosphorylating activity. (BBB)

13073 THE SENSITIVITY OF X-IRRADIATED CELLS TO ULTRAVIOLET RADIATION. P. O'B. Montgomery, Paul D. Minton, Rolland C. Reynolds, John Prince, and Charles L. Chapman (Univ. of Texas, Dallas). Texas Rept. Biol. Med., 22: 556-65(1964).

The technic of uv flying spot television microscopy is described and the use of this technic for the exploration of the effects of uv irradiation of living cells is discussed. It is used for an evaluation of the relative sensitivity of x-irradiated cells and normal cells to uv radiation. HeLa cells received 600 R of x radiation, delivered over a period of six min by a 250 kv x-ray machine. This dose was selected because it had an inhibitory effect on mitosis in this cell strain. Ninety percent of such x-radiated cells survived for more than 24 hr and some continued to grow and produce mononucleated and multinucleated giant forms. The control group was prepared and treated in an identical way except that it was not exposed to x radiation. One hour later both groups of cells were subjected to uv irradiation by the uv flying spot microscope. After eight hr of uv irradiation 33.9% of the total x-irradiated population were dead, while after the same length of time only 234 control cells, or 24.2% of the control population, had died from the effects of the uv radiation. A more quantitative analysis of the experimental data was made than is possible by simple comparisons of the percentage of dead cells in the respective cultures at particular time intervals. In order to adequately analyze the data, a mathematical description of the data was obtained by fitting a curve to the results for each cell population using the statistical method of least squares. After considering the possible mechanisms of cellular destruction, a curve of the second degree was decided upon as best describing the experimental data. The results show that the death rate of the x-irradiated cells is higher than the death rate of the control cells for eight hr. It is therefore evident, both from a visual comparison of the survival curves and from a comparison of the derivatives of these two curves, that the x-irradiated culture has a higher death rate while being uv-irradiated and is therefore more sensitive to uv radiation, than is the control culture. These data are in agreement with other reports and indicate that the effects of x and uv radiation have some overlap in their expression of damage despite the fact that the basic mechanisms of the two forms of cell injury are different. X radiation produces cell injury by ionization and this process is essentially random in nature. The effects of uv irradiation, on the other hand, are due to absorption of the energy of the photon by the aromatic groups in the cell; since these groups are not random in their distribution, uv cell injury is nonrandom in distribution. Some degree of damage to the DNA content of the nucleus is presumed to have occurred during x irradiation, which expressed by the presence in the culture of cells which are more sensitive to subsequent uv irradiation than the controls. The mechanism of the production of these cells may be that the more uv sensitive cells in the x-irradiated cultures are more sensitive because many of the action sites of uv and x rays are common sites of action and are essentially nonreparable. The x radiation may then be assumed to have destroyed these sites and the additional amounts of uv completed the destruction pattern and cell death resulted sooner than in cells which were not x irradiated. (BBB)

13074 THE EVALUATION OF THE SENSORY PROCESSES AND THEIR SIGNIFICANCE FOR RADIOBIOLOGY AND RADIOPATHOLOGY. Emil von Skramlik and Georg Sitzlack (Abteilung Strahlenschutz des Amtes fuer Kern-

forschung und -technik, Berlin). Z. Ges. Inn. Med. Ihre Grenzgebiete, 16: 457-69(June 1, 1961). (In German)

Irradiation affects sensory processes variably. The sensitivity of visual organs, such as the lens, varies with the type of animal and the type and energy of radiation. In mice cataracts are produced by 15 to 30 R of x ray, or by 1 rep of fast neutrons. For rats, rabbits, dogs, and humans the effectivity increases in the order, x ray, β radiation, and neutrons. Morphological and pathological changes are observed in other portions of the eye after irradiation with doses up to several thousand R. As measured by the ear muscle reflex auditory capacity and sensitivity is reduced in guinea pigs by irradiation with 350 R of x ray. A few studies indicate that human audition is enhanced initially, but subsequently is depressed by radiation. Positional and statokinetic reflexes are accentuated in rabbits after irradiation. Radiation produces a dissociation between rotatory and caloric nystagmus in experimental animals. Olfactory sensitivity is enhanced in irradiated humans, but it worsens later and becomes abnormal, suggesting alteration of central sensory processes. Taste perception of sweet and bitter substances is sometimes accentuated after irradiation. Action currents of sensory nerves in the paws of cats and rabbits are markedly reduced by irradiation with 500 to 5000 R. In humans therapeutically irradiated decreased pressure sense has been reported. Interoceptors are also affected by irradiation. Chemoreceptors in small intestine of cats exposed to 600 R of x ray show phasic alterations 6 days later, and respiratory patterns are also affected. All studies indicate that sensory processes are very sensitive to radiation. The central sensorial regions are most sensitive, but the peripheral receptors are less sensitive. The sensory nerves appear to be the least sensitive. The synaptic junctions are very sensitive, probably because of damage to the ganglial cells by ionizing radiation. (BBB)

13075 EXPERIMENTS ON THE INACTIVATION OF PATHOGENIC BACTERIA WITH X RADIATION. Heinz Beutel (Universitat, Munich). Zentr. Bakteriol. Parasitenk. Abt. I. Orig., 186: 179-88(1962). (In German)

For the purpose of developing a biologic dosimetric technique, a reproducible procedure was devised for radioinduced activation of bacteria pathogenic to man and animals. The bacteria suspended in buffered media contained in glass tubes were magnetically stirred and irradiated with unfiltered x rays generated at 50 kv. The doses tested varied from 100 to 2000 kR. The doses required for achieving absolute inactivation of bacterial suspensions at concentrations ranging from 2.0×10^8 to 2.0×10^{10} were found to range from 750 to 1500 kR for Brucella abortus (strain Buck 19), and from 2000 to 2500 kR for Listeria monocytogenes. Suspensions of the vegetative form and the spores of Bacillus anthracis, at concentrations ranging between 1×10^6 and 1×10^7 per ml were not completely inactivated by doses as high as 2.5 MR. It is pointed out that no accurate biological method for the measurement of radiation doses is available, and the dosimetry based on the irradiation of bacteria might be given preference to the physical methods of measuring doses. Changes in the morphology of colonies subsequent to irradiation were occasionally noted in B. abortus and B. anthracis. These changes were investigated, but no changes in mouse virulence were detected. The shapes of the inactivation curves of some gram-negative and gram-positive bacteria and of anthrax bacilli and spores are illustrated and discussed in terms of the age of the cultures. The shapes of these curves show that radiosensitivity differs at the various growth phases. (BBB)

13076 ON THE FATE OF WOMEN CASTRATED BY X RAY. H. Radzuweit (Friedrich-Schiller Universitat, Jena, Ger.). Zentr. Gynaekol., 85: 1697-1707(Nov. 30, 1963). (In German)

The possibility of a causal relation between radiation menolysis and subsequent development of carcinoma was studied. Of 7770 cases of carcinoma, 0.83% had been irradiated for a benign gynecological growth. Others of the patients had been irradiated previously for ovarian, uterine, and other types of gynecological carcinoma. These were 4.65% of the patient total. The average interval between previous irradiations and the later ones was from 12.3 to 13.2 yr. Comparison of the pattern of carcinoma localization observed after radiation menolysis with the normal distribution indicated that there was no likelihood of any causal relation between carcinoma occurrence and irradiation. An additional argument against such a relation was that the intervals between radiation menolysis and carcinoma decreased with increasing ages of the patients. The average age when carcinoma appeared after radiation menolysis was the same as when it usually appeared without irradiation. Radiation castration, even at the highest radiation dose, produced no shift in age susceptibility to carcinoma. (BBB)

13077 EFFECT OF IRRADIATION ON PREVENTIVE PROPERTIES OF SERA OF GUINEA PIGS IMMUNIZED WITH LIVE BRUCELLOSIS VACCINE. Z. V. Shevtsova (Inst. of Epidemiology and Microbiology, Academy of Medical Sciences, USSR). Zh. Mikrobiol., Epidemiol. i Immunobiol., No. 9, 76-81(Sept. 1964).

The effects of irradiation on the preventive properties of the sera of guinea pigs irradiated with a dose of 200 R at various intervals before and after immunization with live brucellosis vaccine are described. The preventive properties were measured with respect to the ED_{50} and the LD_{50}. The effect depended on the interval between irradiation and vaccination. When the animals were vaccinated 24 hours before or after irradiation, a retardation in the rise of the preventive properties was observed on the 15th day of immunogenesis but it was not evident on the 30th day; when the animals were vaccinated on the 3rd day after irradiation (in the period of pronounced symptoms of radiation sickness), the effect of irradiation was considerably stronger and even on the 30th day the preventive properties were three times less than in the control animals. When the animals were vaccinated 30 days after irradiation no difference was observed between irradiated and control animals. Irradiation on the 30th day of immunogenesis showed no effect on the preventive properties of the sera. No correlation was found between the quantity of agglutinins in the sera and their preventive properties. (OTS)

13078 EFFECTS OF WHOLE BRAIN Co-60 GAMMA IRRADIATION ON CORTICAL AROUSAL IN THE BURRO. Yoshimasa Naitoh. Thesis, Minneapolis, Univ. of Minnesota, 1964. 110p.

Radiogenic functional alterations in the adult central nervous system (CNS) following single external irradiation of the whole brain with doses of 200R, 400R, 500R (for clinical study only), 600R, and 1000R (a preliminary study) at dose rates of 11-17 R/minute were studied. Adult male burros (Equus asinus) were chosen as the subjects. Pavlovian conditioning was used. A noxious electro-cutaneous stimulus applied to left forelimb was used as the reinforcer. A 512 c/s tone, clicks, and a buzzing noise were the positive conditioned stimuli (CS^+'s) which elicited the conditioned responses (CR's) of anticipatory flexion-extension of the left forelimb and cortical arousal. Clinical study showed that (1) the median lethal dose was about 550R, (2) neurological signs after cranial exposure were similar to those following whole-body exposure, (3) the leukocytic and autonomic responses were unlike those following whole-body exposure, (4) a pattern of observed neurological signs suggested functional alterations in limbic lobe, hypothalamus, brain stem, and vestibulo-cerebellum, and (5) the burros would not undergo physiological crises with doses of 400R or less. Analysis of the CR data showed that rapid loss of leg flexion-extension CR and conditioned cortical arousal to the CS^+'s occurred if the burros were irradiated with 400R or more and their CR's were tested under extinction. Since the 600R group suffered from acute radiation sickness, observed facilitated extinction of the CR's could be due to radiation sickness alone. It is suggested that facilitation of extinction of the CR's after 400R possibly resulted from radiogenic functional alterations in the allo- and sub-cortical integrations. (A.G.W.)

13079 THRESHOLD FOR IMMEDIATE DETECTION OF X-RAYS BY THE RAT. Dale Duane Morris. Thesis, Tallahassee, Florida State Univ., 1964. 21p.

Four male, 12-week-old Sprague-Dawley rats were used to determine the threshold for behavioral response to x irradiation using the conditioned suppression technique with a VI schedule. Standard instrumental conditioning equipment was used. The box was equipped with a single lever, liquid reinforcement mechanism, and a grid floor through which an electric shock could be applied to an animal's feet. The radiation source was a G. E. Maxitron x-ray machine. All animals were maintained at 80 per cent body weight and initially trained to stable performance on a VI-1 schedule with 16 per cent sucrose solution as reinforcement. After a stable baseline was obtained, animals were placed in the operant box beneath the x-ray machine for a half-hour session each day. While the animals were actively pressing the lever for reinforcement, the shutter was opened and a 15-second x-ray exposure of 0.5 R/sec was administered followed immediately by an electric shock. After conditioned suppression had been established, the dose-rate was decreased during the following sessions in an effort to establish threshold. The results were analyzed in terms of the suppression ratio, which is the response rate for the 15-second irradiation period divided by the response rate during the 15 seconds immediately preceding the irradiation period. All animals exhibited conditioned suppression. The results indicate that x rays at a dose rate as low as 0.01 R/sec can be an effective pre-aversive stimulus for the rat. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13080 THE EFFECTS OF CONTINUOUS LOW LEVEL IRRADIATION ON REPRODUCTION OF ALBINO RATS EXPOSED DURING LATE PRENATAL AND EARLY POSTNATAL DEVELOPMENT PERIODS. Henry Buford Pace. Thesis, College Station, Tex., Agricultural and Mechanical Univ., 1964. 104p.

A study was conducted to obtain data on effects of chronic radiation at levels of 1, 2, 5, 10, 20, and 40R per day for a total dose of 30, 60, 150, 300, 600, and 1200R respectively on Holtzman strain offspring irradiated for 30 days beginning on the 15th day of gestation. There were no apparent real effects from continuous radiation to the dams that produced offspring at treatment levels of 0, 1, 2, 5, 10, 20, and 40R per day with regards to the number of females littering and average litter size produced. Birth weights were significantly decreased ($P < .05$) in groups receiving 20 and 40R per day as compared with non-irradiated controls. Body weights at birth, 14, 23, and 300 days of age were significantly depressed in the group receiving 40R per day as compared with non-irradiated controls. The average weights of testes at 65, 170, and 300 days of age were significantly reduced ($P < .01$) in the groups receiving 5, 10, 20, and 40R per day as compared with non-irradiated controls. The effects of 5R (150R total) per day for 30 days on the developing offspring to include the sensitive prenatal period is not as detrimental to the testes as 150R given acutely on days 17, 18, 19, 20, 21, or 22 of prenatal life. There was a significant decrease in total number of tubules and average number of active tubules ($P < .05$) in the groups receiving 5, 10, 20, and 40R per day as compared with controls at 170 and 300 days of age. It is concluded that gamma radiation at levels of 10, 20 and 40R per day (23 hours) will cause sterility in males and probably in females exposed from the 15th day of gestation throughout the 23rd day of postnatal life. (A.G.W.)

13081 EFFECTS OF WHOLE-BODY X-IRRADIATION ON THYROID FUNCTION AND IODINE METABOLISM IN THE MOUSE. Chang Won Song. Thesis, Iowa City, Iowa State Univ., 1964. 79p.

Mice were placed on a low-iodine diet for seven days before irradiation. They were then subjected to whole-body x irradiation with an exposure dose of 1000 R. A tracer dose of ^{131}I was injected intraperitoneally into mice immediately and at various intervals after x-ray exposure. Thyroid function and distribution of ^{131}I in various organs of the body was studied for 48 hours post irradiation. Thyroid function was measured by (1) thyroidal ^{131}I uptake, (2) plasma protein-bound ^{131}I, (3) radiochromatographic studies of thyroid tissue hydrolysates, and (4) thyroid hormone release. It was found that irradiation retarded the turnover of ^{131}I in the thyroid gland as compared to the controls. The plasma ^{131}I conversion ratio in the irradiated animals was lower than that of the controls. Radiochromatographic studies of thyroid tissue hydrolysates showed a reduction in rate of formation of thyroid hormone. The irradiated gland had a greater proportion of ^{131}I in the earlier stages of thyroxine and triiodothyronine synthesis than that of controls. The amount of ^{131}I in the liver and kidney was significantly lower during the first 24 hours after irradiation. The amount of ^{131}I in the stomach was 6–8 times higher in irradiated animals from 6 to 12 hours after irradiation. Values similar to controls were observed at 24 hours post irradiation. It was concluded that a whole-body exposure of 1000 R of x rays in the mouse acted as a stressor to reduce thyroid function. It also caused temporary changes in the distribution of labeled iodine in the various organs of the body. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13082 EFFECTS OF MIXED NEUTRON-GAMMA RADIATION ON FOREST LITTER PRODUCTION. John Thurlow McGinnis. Thesis, Atlanta, Emory Univ., 1964. 118p.

Forest litter production was studied in the vicinity of the U. S. Air Force air-shielded reactor in north Georgia with special emphasis on mixed neutron-gamma radiation as an environmental variable. Observations were made in five oak-hickory forest stands on 25 to 30 per cent northwest facing slopes along a radiation gradient ranging in distance from 500 to 4000 feet from the ten-megawatt reactor. The reactor operated sporadically throughout the four years of observation, 1959 through 1962, but with high flux emissions of mixed neutron-gamma radiation occurring at ecologically significant times during June 1959 and August 1960. The emissions ranged in intensity from 15,000 rads at 500 feet to 700 rads at 1600 feet from the reactor in 1959 and 20,000 to 800 in 1960. The 1959 exposure effects were reflected in the litter production by the trees the following year. Fifteen-thousand rads exposure resulted in complete inhibition of leaf production and an exposure of 4700 rads resulted in a 42 per cent reduction in total litter production. The August 1960 exposure yielded a much reduced effect in the 1961 productivity. White oak and black oak group leaves arising from irradiated buds were significantly heavier than non-irradiated leaves while the hickories exhibited little chance in average leaf weight. The number of leaves produced by the white oaks, black oaks, and hickories was markedly affected following exposures of 5000 rads while dogwood showed little effect. Pines were completely eliminated at this exposure. Only lethal or near lethal exposures resulted in early leaf release by trees. Understory species tended to be more resistant than the canopy species and exhibited very rapid recovery responses. Exposures of lesser intensities resulted in effects of lesser magnitude with probable recovery with respect to apparent growth and vigor by the major species within a few years. (A.G.W.)

13083 X-IRRADIATION OF CALF THYMUS DEOXYRIBONUCLEOPROTEINS: CORRELATED ELECTRON-MICROSCOPIC AND CHEMICAL STUDIES. John Douglas Leith, Jr. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 333p.

Calf thymus deoxyribonucleoprotein (DNP) was prepared and the final product was dissolved in water. This DNP was then irradiated at concentrations of 0.2 to 0.6 mg/ml with unfiltered 140-kvp x rays. Very little "after-effect" was noted in subsequent analysis. Apparent reduced specific viscosity (η_{sp}/c) was determined using an Ostwald-Fenske viscometer with a shear rate for water of 2660 per second. The D_{37} was 88 rads, or 0.02 ev/P atom in DNA. Chemical changes were followed by fractionating the DNP by filtration through Whatman #1 filter paper, and measuring the appearance in the filtrate of DNA, histone (material soluble in $HgSO_4/H_2SO_4$ and giving the Millon reaction for tyrosine), and total protein (measured by an alkaline copper tartrate method using bovine serum albumin as standard). Histone

appeared after low doses of irradiation, with D_{37} of 570 rads, or 0.14 ev/P atom in DNA. DNA and total protein appeared at exactly the same rates, showing a D_{37} of 4300 rads, or 1.1 ev/P atom in DNA. Electron microscope changes consisted of breaks across 100 Å fibrils, with subsequent retraction of free ends to form loose clumps of DNP fibrils. Changes in width of individual fibrils were not seen. It is concluded that the viscosity drop results from rupture of protein bridges, and that histone is next removed in a one-hit process. The presence of histone closely associated in DNP appears to protect it from radiation damage. This is inferred from the rate of release of DNA into filtrates after irradiation. The D_{37} value for this is 10 to 20 times higher than reported D_{37} values for breakdown of equivalent concentrations of DNA. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13084 ECOLOGY OF A SHRUB SYNUSIA IN AN IRRADIATED ECOSYSTEM. William A. Reiners. Thesis, New Brunswick, N. J., Rutgers Univ., 1964. 197p.

The extent to which environmental factors other than ionizing radiation may influence the radiosensitivity of plants in natural systems was studied. The species studied are ericaceous shrubs (Gaylussacia baccata, Vaccinium vacillans, V. angustifolium) commonly united as a shrub stratum. Although not identical, growth habits, ecological requirements, and phenologies are quite similar in the area in which ranges for these three species overlap. Consequently these species were studied as an ecological unit, a phytosociological aggregate termed a synusia. Investigations were conducted along three lines of approach: (1) information was collected on the ecology of the laboratory region and on the shrub synusia; (2) environmental factors were measured along the gradient of radiation effects in the irradiated forest; (3) experiments were conducted to test the effect of several environmental factors on the radiosensitivities of the shrub species. On the basis of observations of the habitat and behavior of the synusia it appeared that environmental alterations in the irradiated forest provided optimal rather than suboptimal or stress conditions. Experimental studies showed that deficient PO_4^{3-}, limiting soil moisture, and low light levels enhanced the growth inhibiting effect of ionizing radiation. There were no descriptive data to show that these conditions exist in the irradiated forest but rather that the reverse is true for light and moisture. There was no evidence that environmental alterations enhanced the effects of ionizing radiation on the irradiated forest shrub synusia. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13085 CHROMOSOMAL ABERRATIONS AND VARIATIONS IN CHROMOSOME NUMBER IN SORGHUM VULGARE TREATED WITH X-RAYS AND THERMAL NEUTRONS. Wei-ning Fu. Thesis, Stillwater, Okla., Oklahoma State Univ., 1963. 98p.

Seeds of Wheatland (Sorghum vulgare, 2n = 20) were treated with x rays and thermal neutrons at five different dosages. Plants from the treated seeds showing 50% or more pollen abortion were selfed. Selfed seeds were planted in head rows. If any plants in a row showed 50% or more aborted pollen, the fertile plants in the same row were crossed with cytoplasmic male sterile Wheatland and simultaneously selfed. Crossed seeds were planted and buds were collected for cytological identification of chromosomal aberrations. A total of 329 samples from both field and greenhouse were examined cytologically. No chromosomal aberrations were observed possibly excepting the chain of four chromosomes identified from only two plants moved to the greenhouse because of very low seed set in the field. Seed set percentage of cytological materials varied greatly among the plants (14-70%). The average seed set percentage for treated materials, cytoplasmic male sterile Wheatland, and normal Wheatland was 38, 43, and 90%, respectively. Since the seed set percentage of treated materials was close to that of untreated cytoplasmic male sterile lines, the seed set is possibly caused by some environmental factors other than chromosomal aberrations. Cells with irregular chromosome numbers (polyploidy and aneuploidy) were observed. Among polyploid cells the highest chromosome number observed was 180, and the most frequent deviation was tetraploid. Among aneuploid cells chromosome numbers from 12 to 38 were observed and the highest frequency was 9 pairs. (Dissertation Abstr. 25: No. 4, Oct. 1964)

13086 STUDY OF RADIATION AND CHEMICAL EFFECTS ON BIOLOGICAL MATERIALS BY THE ELECTRON PARAMAGNETIC RESONANCE METHOD. L. A. Blyumenfeld and A. E. Kalmanson. p.45-52 of "Pervichye i Nachal'nye Protessy Biologicheskogo Deystviya Radiatsii." Moscow, Publishing House of the Academy of Sciences, 1963.

When crystalline amino acids in the dry state were irradiated with 10^6-10^7 R from a cobalt source intensive EPR spectra were obtained showing a characteristic pattern that depends on the amino acid structure. In most amino acids, 10^7 R caused the appearance of free radicals equivalent to about 10^{19} paramagnetic units/g of amino acid. The effect was due primarily to interaction of unpaired electrons with protons and with nitrogen nuclei. However, in sulfur-containing amino acids, the g-factor was altered, due to localization of the unpaired electrons in the sulfur atom. Irradiation of native proteins or of lyophilized tissues containing up to 60-80% protein gave a completely different EPR spectrum, showing a reduction in the number of free radicals by a factor of 2-3 and lacking the resolution of the spectra of the component amino acids. The spectra obtained appeared as single narrow peaks without specific structure. Similar results were obtained when enzymes were frozen and lyophilized in the presence of substrate. Irradiation of nucleic acids, nucleoproteins, DNA, and of various complex nucleic acids also revealed formation of free radicals characteristic of the nucleoside structures. However, whereas irradiation of a nucleoside produced free radicals equivalent to $10^{18}-10^{19}$ paramagnetic units, this intensity was reduced by a factor of 2-3 when irradiation was performed on high molecular weight nucleic acids. This is considered important, since radiation damage to nucleic acid molecules is 10-50 times higher in high-molecular-weight polynucleotides than in low-molecular-weight compounds. A possible effect of added water on the electron paramagnetic resonance spectra of irradiated biological molecules is discussed. (OTS)

13087 IMMEDIATE RESPONSE IN THE PIGEON TO BRIEF X-RAY EXPOSURE. J. Smith, J. Hendricks, D. Morris, and R. Powell. 6p. (CONF-556-5)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

The effectiveness of x rays paired with a brief electric shock as a warning stimulus in the white Carneaux pigeon was investigated. The irradiation exposure terminated with a brief electric shock. After a stable baseline was obtained, the birds were taken to the x-ray facilities and run for a 45 min session each day. While the birds were actively pecking the key, the shutter was opened and a 10 sec x-ray exposure was administered followed by an electric shock. The results were analyzed in terms of the suppression ratio which is the number of responses made during the 10 sec irradiation period divided by the responses made during the 10 sec immediately preceding the irradiation period. In 3 of 6 birds tested, significant suppression was noticed during the exposure period when the dose rate was 2 R/sec. Little or no suppression was observed in remaining birds at this dose rate. The suppression dose for one bird was found to be 6 R/sec. It was concluded that x rays can act as a warning stimulus, but the dose rate must be quite high to see it in all birds. (P.C.H.)

13088 RADIATION-SENSITIVE INTERMEDIATES IN THE BACTERIAL LUCIFERASE REACTION. C. H. Burns and G. Hoyt Whipple (Univ. of Michigan, Ann Arbor). 20p. (CONF-556-7)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Studies were made on the mechanism of radiation effects

on the bacterial luciferase reaction. The reversible inhibition of the steadystate bacterial luciferase reaction in vitro that occurs simultaneously with its exposure to x irradiation was found to be at least partly accounted for by a similar action of x radiation on the nicotinamide adenine dinucleotide-flavin monophosphate (NADH-FMN) oxidoreductase reaction that prepares the substrate flavin mononucleotide ($FMNH_2$) for luciferase proper. The rate of production of $FMNH_2$ by this enzyme is reversible retarded while being exposed to x radiation; the rate of uptake of NADH, however, is accelerated rather than retarded. $EMNH_2$ and the reduced form of luciferase do not appear to display sufficient radiosensitivity to account for the original observation on the bacterial luciferase system. The results are discussed from the standpoint of the existence of NAD-linked oxidoreductases in every living cell and a way in which their reversible inhibition during radiation exposure may initiate radiation injury to cells. (P.C.H.)

13089 INFLUENCE OF PARTIAL-BODY X-IRRADIATION ON DEVELOPMENT OF THE ENZYME SYSTEM WHICH CATALYZES THE DESULFURATION OF A PHOSPHOROTHIOATE IN THE LIVER OF YOUNG MALE RATS. Bernard E. Hietbrink. 7p. (CONF-556-10)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Studies were made on the effects of x radiation on the development of the enzymes that are responsible for the oxidative desulfuration of phosphorothioates in the livers of young male rats. The results showed that the livers of irradiated and unirradiated 23-day old rats exhibited low enzyme activity within the age range of 23 to 31 days. In contrast, weanling rats that received 200 or 400 R failed to exhibit an increases in enzyme activity during the first 22 days after irradiation. Shielding the liver and testes areas did not substantially reduce the inhibitory effect of 200 R of whole-body x rays on the development of the phosphorothioate-oxidizing enzyme. However, shielding the head and liver area significantly reduced the amount of inhibition caused by 200 R of x rays on the development of the enzyme. The effects of shielding the body while exposing the head inhibited the development of the enzyme to an extent similar to that caused by 200 R of whole-body radiation. The results indicate that there is an area in the head that appears to be radiosensitive, that the lesion caused by radiation inhibits the development of enzyme activity and that radiation also damages other sites in the body that are involved in the development of phosphorothioate-oxidizing enzymes in the livers of young male rats. (P.C.H.)

13090 QUANTITATING TREATMENT EFFECTS ON TRANSPLANTED TUMORS WITH MLD DETERMINATIONS. Frank R. Hendrickson. 6p. (CONF-556-13)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

A general method is presented by which the effectiveness of an antitumor agent can be accurately assessed. Relative changes in the size of the tumor following treatment are used in order to gain maximum information with a minimum number of animals. This way the influence of host-resistance on cure of the tumor is circumvented. The matching of predicted survival curves with experimental curves in the myeloma tumor in mice was used to demonstrate the practical application of the method in analyzing results. Advantages of the method are listed. (P.C.H.)

13091 THE TURNOVER OF LYMPHOID CELLS IN BLOOD AND BONE MARROW OF NORMAL AND IRRADIATED DOGS. G. Keiser, B. J. Bryant, and V. P. Bond. 4p. (CONF-556-12)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Radiation effects on the activity of lymphoid cells in the blood and bone marrow of dogs were investigated. A medium tissue dose of 125 R was given to young dogs at 23.1 R/min to each side of the dog. The results showed that lymphoid cells of blood and marrow have a significantly increased proliferative activity during the early recovery phase from whole-body irradiation, compared with that of lymphoid cells in the non-irradiated dog. The proportion of large and medium lymphoid cells increased in the irradiated dogs with high and slightly increased turnover rates, respectively. A migration of lymphoid cells from the blood in the marrow, as described previously in the normal dog, was confirmed in the irradiated dog. (P.C.H.)

Radiation Effects Therapy and Countermeasures

13092 (CEA-R-2582) ETUDE DES PROPIETES RADIOPROTECTRICES DE COMPOSES HETEROCYCLIQUES AZOTES. (On the Radioprotective Properties of Heterocyclic Nitrogenous Compounds). Renaud Rinaldi and Yvette Bernard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1964. 15p. Dep. (mn).

A study was made of the possible radioprotective properties of certain derivatives of imidazole and other compounds of similar structure. The results showed: (1) that the derivatives resulting from the presence in the imidazole ring of the mercapto, methyl, carbonyl, or benzyl groups are inactive: these substitutions appear to destroy the significant radioprotective activity of the imidazole; (2) that benzimidazole, on the contrary, seems to possess highly interesting properties. The survival percentage obtained with mice treated with benzimidazole and exposed to lethal irradiation led to a careful study of this substance, with a view to define optimum activity conditions, and to determine the mechanism responsible for its radioprotective action. In order to clarify the mechanisms of action of radioprotective chemicals, studies were made of the action of these bodies on the internal temperature of mice, and their radioprotective activity in vitro, in a solution of irradiated hemin. (auth)

13093 (JPRS-28356(p.15-21)) THE EFFECT OF CORTISONE ON THE DEVELOPMENT OF LATE REACTIONS IN FATALLY IRRADIATED RATS, TREATED WITH HOMOLOGOUS BONE MARROW. K. A. Lebedev. Translated from Probl. Endokrinol. i Gormonoterap., 10: No. 5, 70-4(Sept.-Oct. 1964).

Cortisone significantly decreased the seriousness of late reactions in rats given bone marrow injections as protection against the lethal effects of 650R x radiation. Data are summarized on the mortality of 650 animals given various combinations of x radiation exposure, bone marrow injections, and cortisone. The possible effects of cortisone on immune reactions to bone marrow in irradiated rats are discussed. (C.H.)

13094 ON STUDIES TO CONTROL THE ONSET OF X-RAY CATARACT OF RABBITS BY A CELL THERAPY METHOD. H. Tiburtius and E. Krokowski (Freie Universität, Berlin). Arch. Ophthalmol., 163: 527-46(1961). (In German)

Six adult rabbits were irradiated with 60-kv x ray, receiving an absorbed dose of 2200 rad to the left lens. Three days previously 3 had received an intragluteal injection of 25 mg of dried, resuspended lens cells. The other 3 animals received this treatment 6 days after irradiation. Similar suspensions of 7.5 mg of cells were given to 37 rabbits 18 to 19 days old. Three days later they were irradiated with x ray directed to the left lens, receiving an absorbed dose of 1640 rad. In 5 other young rabbits the treatment was given 3 days after irradiation. Subsequently, if the lenses became totally opaque the animals were killed. Animals whose lenses did not become opaque were killed after 150 to 194 days. The dry weight of each lens was measured. The 6 adult animals did not react favorably to the treatment, and developed conjuctivitis, keratosis, and complete epilation. After 30 days all of the adult animals developed complete lens opacity. No protective effect of the cell preparation was observed in these animals that had received 2200 rad. Complete opacity developed in 30 of the young

animals between 44 and 79 days after irradiation. Of these, 26 had received the cell preparation prior to irradiation, and 4 had received it afterwards. The exact time distribution for development of opacity in the young animals was 44 to 49 days for 3 animals, 50 to 59 days for 9 animals, 61 to 69 days for 15 animals, and 79 days for 3 animals. Eleven of the young treated animals developed only partial lens opacity. Ten of these had received the cell preparation prior to irradiation. In the animals that had been treated after irradiation the lens effects were much more marked than in the other 10 animals. In the animals with totally opaque lenses the weight of the irradiated lenses was between 47 and 71% of the lenses on the unirradiated side. In the animals with partially opaque lenses the relative weight was between 57 and 94% of the lens weight of the unaffected side. (60 references) (BBB)

13095 EXPERIENCE OF BONE MARROW TRANSPLANTATION ON SELECTED CASES IN INDIA. V. B. Lal. Bibliotheca Haematol., 19: 294-300(1964).

The use of bone marrow grafts in the treatment of malignant diseases and lethal irradiation exposure is discussed. Its application in 10 patients with severe anemia is described along with the technique of transplantation. Usually 150- to 180-ml volumes of marrow were injected into the recipients. Favorable results were noted in most cases, and none developed the secondary syndrome. (BBB)

13096 ADVANTAGE OF LUGOL SOLUTION IN CUTANEOUS CONTAMINATIONS BY RADIOACTIVE IODINE. R. Nicolai, P. Jockey, G. Hugot, and P. A. Drion. Bull. Inform. Sci. Tech. (Paris), No. 86, 71-2(Sept. 1964). (In French)

Two cases of skin contamination with radioactive iodine, which could not be decontaminated by the usual method, were treated with an application of lugol solution. In one case the contamination was immediately reduced from 200 to 75 c/sec. A second application reduced it to 35 c/sec. In the second case the contamination completely disappeared after one application of lugol solution. Lugol solution consists of 2.5 g of I_2 and 5 g of KI in 50 cm^3 distilled water. (J.S.R.)

13097 ON THE QUESTION OF A THERAPY FOR RADIOINTOXICATION. Ernst Spode (Institut fur Medizin und Biologie, Deutsche Akademie der Wissenschaften, Berlin). Deut. Gesundheitsw., 16: 1469-74(Aug. 10, 1961). (In German)

When radioisotopes are ingested there are three general procedures that can be used to reduce resorption. These are: administration of compounds that lead to precipitation of the radionuclide, use of emetics, or acceleration of elimination by laxatives. The choice of treatment depends on the resorption characteristics of the radioisotope ingested, and the time interval between ingestion and start of the treatment selected. After inhalation, absorption of radionuclides through the mucosa can be reduced by administration of vasoconstrictor agents, such as adrenalin or neosynephrin. In most cases where the accidental incorporation of radionuclides has occurred, the most rational procedure is to administer chelate formers to accelerate elimination of the radioactivity. Chelate formers are organic compounds that form coordination compounds with heterocyclic rings. Most of the chelates formed are soluble or very diffusible, and so are eliminated from the body very rapidly. Among the first of these substances tested was 2,3-dimercaptopropanol (BAL). It is most effective for removal of Pb, Bi, or Po. Na citrate has some effect to remove Pb, but it loses its effectiveness very rapidly in the body because it is destroyed by metabolic processes. Generally, the most effective compounds found so far are the polyaminopolycarboxylic acids, and compounds related to them. The prototype of this class of compounds is ethylenediaminetetraacetic acid (EDTA). These compounds are far superior to other compounds to accelerate excretion of the heavy metals, such as the rare earths, Pu, Y, Sr, Hg, and Ru. Several substituted polyaminopolycarboxylic acids are more effective than EDTA. These include DTPA, PDTA, and HDTA. However, effectiveness of the compound used will vary considerably with the metal incorporated, because biological effects are closely related to chemical chelation. Other soluble substances that act similarly to ion-exchange agents include Zr salts and condensed polyphosphates. These are somewhat effective for removal of Ce and Sr. References cited, 45. (BBB)

13098 RESTORATION FROM RADIATION DAMAGE WITH NUCLEOTIDE MIXTURES IN MICE. T. Sugahara, T. Tanaka, and H. Nagata (Kyoto Univ. and National Kyoto Hospital). Folia Biol. (Prague), 12: 461-4(1964).

Restorative effects of mixtures of 3′(2′)- or 5′-ribosemononucleotides from RNA were studied on irradiated mice. Survival time for repeated irradiations in mice and reproductive capacity of irradiated bone marrow cells in the spleen of heavily irradiated recipient mice were used as test systems. The mixtures were administered after the star of irradiation. A significant increase in survival time of mice and cell reproductivity were observed with 3′(2′)-nucleotides but not so with 5′-nucleotides. The mechanisms of the effects and their differences are discussed. (auth)

13099 ON THE PROTECTIVE EFFECT OF 2,4 DINITROPHENOL. A. Vacek and D. Rotkovska (Inst. of Biophysics, Brno). Intern. J. Radiation Biol., 8: 285-9(1964).

Results are reported from studies on the effects of injected 2,4 dinitrophenol (DNP) on whole body oxygen consumption by rats and mice and oxygen tension in rat and mouse tissues. Results indicate that an increase in the oxygen consumption in intact animals was accompanied by a decrease of pO_2 in the tissues. Administration of DNP at a dose of 1.5 mg/100 g gave no protective effect in rats or mice exposed to 800 R x radiation. Administration of DNP at a dose of 3 mg/100 g gave some protection to mice exposed to 650 R. (C.H.)

13100 ALPHA-AMIDINIUM THIOSULFATES (BUNTE SALTS) AS ANTIRADIATION DRUGS. Ludwig Bauer and Karen Rover Sandberg (Univ. of Illinois, Chicago). J. Med. Chem., 7: 766-8(Nov. 1964).

For possible radiation-protective agents, the synthesis of functional analogs of cysteamine, $HSCH_2CH_2NH_2$, was carried out. α-Mercaptoamidines, $HSCHRC(=NH)NH_2$, and their derivatives were considered; although α-mercaptoamidines themselves are yet unknown, some of their thiol esters and Bunte salts have been prepared. Preliminary biological data revealed that some of the known α-amidinium thiosulfates (Bunte salts), $RCH(S_2O_3^-)C(=NH_2^+)NR'R''$ (I), afford protectivity; hence, additional members of this series were synthesized to learn which molecular modification brings about increased activity. Biological data of all 22 of the α-amidinium thiosulfates which have been tested to date are compiled in a table. These data show that derivatives of acetamidine (I, R = H), on the whole, showed considerably more radio-protective activity than their homologs I (R = CH_3 and C_6H_5). On the other hand when the N-alkyl side chain of the acetamidine series is increased (R = R′ = H; R″ from H to n-C_5H_{11}), considerable activity is maintained. Although no optimum chain length was determined, the long-chain n-nonyl and n-decyl derivatives were devoid of activity. The synthesis of the α-amidinium thiosulfates which is described follows essentially that developed previously. α-Halonitriles were converted to the corresponding α-chloramidine hydrochlorides, which were treated with sodium thiosulfate to yield I. In one instance, when a water-soluble product was obtained, the α-amidinium Bunte salt could be isolated when thallous thiosulfate was used instead of the sodium salt. Twelve new members of the series are listed, together with their yields, melting points, crystallization solvent, and elementary analyses. (BBB)

13101 RADIOBIOLOGY. [PART] VII. Honjo Ichijiro and Yuong-tchel Tchoe (Osaka Univ.). Kagaku No Ryoiki, 17: 817-30(1963). (In Japanese)

Environmental factors that affect radiation processes in biological systems are discussed. Chemical protection

against radiation is considered first. The terms percent protection and dose reduction factor are defined. Reagents that have been found effective for protection against radiation include cysteamine, cystamine, and s-(2-aminoethyl) isothiuronium. Direct and indirect protection of living macromolecules in vitro is discussed followed by discussion of protection against radiation at the cell and higher levels. The relation between chemical protection and LET is described. Mechanisms of chemical protection against radiation, which consider free radical reactions, energy transfer, deoxygenation, and the mixed disulfide hypothesis, are included. Chemicals that enhance radiation effects are mentioned. Temperature is another environmental factor that greatly affects radiation processes. Higher temperature generally enhances radiation damage, however, effects of temperature become complicated when phase changes occur as temperature is varied. The role of water as an environmental factor is described briefly. (TTT)

13102 EXPERIMENTAL STUDY ON EFFECT OF ISOLOGOUS BONE MARROW TRANSPLANTATION IN RATS GIVEN A LETHAL DOSE OF RADIOACTIVE PHOSPHORUS. Kee Suk Whang (Kyung-Pook National Univ., Taegu, Korea). Korean J. Internal Med., 5: 393-4(June 1962). (In Korean)

One week after the administration of ^{32}P (5 μC/g body weight) intraperitoneally in adult male rats, a suspension of about 100 million bone marrow cells was injected into the tail vein. The administration of ^{32}P was followed by determination of hemoglobin levels and reticulocyte, placelet, leukocyte, and differential counts every other day during the first week, every three days during the following three weeks, and once a week during the subsequent one month. The surviving rats were sacrificed on the 60th day. Bone marrow samples were taken from the right femur of the rats and blood specimens were obtained for hematologic examination. The effect of the bone marrow transplantation was evaluated in terms of 60-day survival rate, recovery of peripheral blood picture, and regeneration of bone marrow. The results showed that the bone marrow transplantation reduced the mortality rate to 40% from 100% observed in the control group which was given only ^{32}P. The rats surviving after successful marrow transplantation showed prompt recovery of the peripheral blood picture and marked regeneration of bone marrow. (BBB)

13103 SURVIVAL OF ISOLATED EMBRYONIC HEART FRAGMENTS FOLLOWING TREATMENT WITH SOME RADIATION PROTECTING CHEMICALS. Wesley Larsen (College of Southern Utah, Cedar City). Life Sci., 3: 539-43(1964).

Heart fragments from 82-day old embryos of the cockroach, Blaberus craniifer, were placed in screw-cap glass vials each containing 5 ml of culture fluid to which penicillin, streptomycin, and mycostatin had been added. There were four hearts in each vial. The fragments were exposed to gamma irradiation from a ^{60}Co source at a rate of 92,620 Rads per hour. Heart beat was selected as the function to determine survival of the tissues. Of 56 heart fragments exposed to 82,000 Rads over ½ stopped beating for a 24 hr period following irradiation. This interval of inactivity was designated as the initial shock period. A period of recovery followed during which 90% of the heart fragments started to function again. Some hearts of the irradiated control group continued to beat for 10 days. It was found that by adding bis (2-amino-4-sulfonamide-phenyl) disulfide (ASPD) the shock period did not appear and the survival time was extended. Using AET, the survival curve followed the general pattern of an untreated control group. There was an initial shock period and a period of recovery. Survival time was slightly longer. The efficacy of AET was seen better at 44,000 R where heart fragments functioned for 59 days. Using isoleucine the survival time was no longer than that of the controls (10 days). (P.C.H.)

13104 THE INFLUENCE OF RADIOPROTECTIVE SUBSTANCES OF THE AMINOTHIOL SERIES ON THE RESPIRATORY FUNCTION (LITERATURE SURVEY). V. I. Kuznetsov and L. I. Tank (Kirov Military Medical Academy, Leningrad). Med. Radiol., 9: No. 9, 92-5(Sept. 1964). (In Russian)

The complex processes involved in the respiratory function may be characterized by the volume of the O absorbed in the tissue and the volume of CO_2 expired during a given time period. The basal metabolism constants may be used to evaluate the efficiency of therapeutic agents. The radioprotective thioamines, such as cysteamine (β-mercapto ehylamine), cystamine and amituronium (S, 2-aminoethyl isothiouronium) have structure similar to that of the natural metabolites and are probably incorporated during the metabolic process. The hypoxia induced by these agents probably plays an important role in the protection mechanism and was the subject of many studies. These studies revealed that cysteamine may exert an exciting or a depressing effect, depending on the dose. Stimulation of the respiratory function by cystamine is due to a direct action on the receptors of the carotid sinus followed by a reflex excitation of the respiratory center; toxic doses cause death by paralyzing this center. The thioamines do not affect the rhythm and the depth of the respiration; their effect on the O balance is not yet completely clarified. It is probable that the cysteamine and cystamine induced increase of the O requirements of the tissue is due to the larger amounts of P-containing compounds formed. Changes in the respiration after administration of cystamine may be ascribed in part to its hyperglycemic effect. The radioprotective property cannot be attributed to hypoxia alone. (Review article) (TTT)

13105 REPARATIVE THERAPY OF UROLOGICAL COMPLICATIONS OF RADIO-SURGICAL TREATMENT OF UTERINE CARCINOMA. P. Quaini and M. Borgno (Universita, Turin). Minerva Ginecol., 14: 137-9(Feb. 15, 1962). (In Italian)

Studies were made on case histories of terminal uterine cancer patients in whom urological complications occurred due to radiotherapy and/or radical surgery. Usually surgery was preceded by radiotherapy. Of a total of 3902 laparotomies, 183 were radical operations for uterine neoplasms. In 90% of these uterine cancer cases, radiotherapy was performed. The urological complications directly caused by radiotherapy and surgery were 20 in number, or 10%. The most frequent complication involved the ureters, and was observed in 13 cases. One lesion was of the ureteral-vesical type and the other six in the bladder. The most encouraging results were achieved by restoring the urinary function by physiological means. For lesions in the extreme distal ureteral region or in the urinary bladder itself, satisfactory functional restoration of urinary excretion can best be achieved through the ureteroneocystostomy. In cases with bilateral ureteral involvement and with extensive metastases, bilateral ureterosigmoidostomy yielded good results even though in most cases the operation simply prolonged the patient's life. The late postoperative complications include the formation of fibrous adhesions. (BBB)

13106 REDUCTION OF RADIATION DAMAGE TO THE INTESTINAL MUCOUS MEMBRANE BY LOCAL HYPOXIA. B. Larsson and S. Stenson (Uppsala Univ. and Univ. of Umea, Sweden). Nature, 205: 364-5(Jan. 23, 1965).

The possibility of reducing acute radiation damage to the rectal mucous membrane by creating a state of local hypoxia in this region during irradiation was investigated. Female albino rats weighing 200-250 g were used. Eleven animals were irradiated with a well-collimated 187-Mev proton beam (LET at the rectal level = 0.5 kev/μ) and 8 animals with γ rays (mean LET = 0.2 kev/μ from a 50 C ^{60}Co source). The whole abdominal cavity was irradiated uniformly at a dose rate of 200-300 Rads/min. In 82% of the cases the changes in the deoxygenated intestinal segments were one or two grades less than in those of the normally oxygenated segments. In 18% there was no clear difference between the two segments. In no case were the changes of the deoxygenated segment more marked than in those of the normally oxygenated one. A protective ef-

fect of local application of norepinephrine and sodium sulfite was demonstrated in the early interval after irradiation. This is believed to be due to the hypoxic state of the tissue during irradiation. (P.C.H.)

13107 PROTECTIVE ACTION OF BENZOYLCARBINOL ON THE VASAL MIOPRAGIA OF THE IRRADIATED LUNG. P. Rocca, G. Sacchitelli, and M. Socci (Università, Genoa). Pathologica, 53: 71-80(Jan.-Feb. 1961). (In Italian)

The therapeutic action of benzoylcarbinol on the pulmonary vascular alterations caused by x radiation is reported. It is preferred to the corticosteroids which may cause serious side-effects. Benzoylcarbinol has an anti-inflammatory action and its trimethylacetate derivative has in addition a capillary protective effect. It is also said to inhibit hyaluronidase-type enzyme activity, possibly involved in connective tissue mucopolysaccharide degradation. The trimethylacetate of benzoylcarbinol was tested, along with combined doses of vitamin C and hesperidin (with capillary-protective action), in rats exposed daily for three days to 100 R (total 300 R) of 180-kv x rays. The drug was injected intramuscularly in 12.5-mg doses three days before, during, and six days after irradiation. The rats were sacrificed at intervals up to 15 days after irradiation and histologic studies made of their lungs. The irradiated, untreated control rats showed marked pulmonary vascular changes. These included destruction, followed by proliferation, of endothelium, generalized capillary swelling, and focal hemorrhagic areas. Larger vessels showed, in addition to endothelial injury, degenerative changes in medial muscle fibers, and fibrotic thickening of the adventitial layer. In the irradiated, drug-treated rats, capillary congestion and swelling were present but the other vascular lesions were not as extensive or as severe as in the irradiated controls. It is concluded that the drug has a protective effect on injury caused to the pulmonary vasculature caused by radiation. It is suggested that its protective effect is exerted by preventing the depolymerization of connective tissue mucopolysaccharides caused by irradiation. (BBB)

13108 MODIFICATIONS OF THE INACTIVATION BY IONIZING RADIATIONS OF THE TRANSFORMING ACTIVITY OF DNA IN SPORES AND DRY CELLS. Hiroshi Tanooka and Franklin Hutchinson (Yale Univ., New Haven). Radiation Res., 24: 43-56(Jan. 1965).

Induced changes in the radiosensitivity of the colony-forming ability of cells (or spores) was compared with changes in the radiosensitivity of the transforming ability of DNA irradiated in these cells (or spores). Both the colony-forming ability of spores of B. subtilis and the transforming ability of DNA extracted from them after irradiation were about four times as resistant to ionizing radiation as were the corresponding activities for dry vegetative cells. The radiosensitivity of the colony-forming ability of irradiated B. subtilis spores was reduced about twofold by a post-irradiation heat treatment, but the transforming activity of extracted DNA was unaffected by such a heat treatment. Thermorestoration of spores occurred only at intermediate humidities, disappearing in spores that were very dry or quite damp. A post-irradiation heat treatment did not affect the colony-forming ability of spores produced in a medium containing 5-bromodeoxyuridine. These spores showed the same radiosensitivity as spores formed in normal media. No effect of a heat treatment after irradiation was demonstrated on: the colony-forming ability of dry vegetative B. subtilis or yeast cells; the transforming ability of DNA irradiated in dry pneumococcus or vegetative B. subtilis cells, or the plaque-forming ability of dry T-1 bacteriophage. (H.M.G.)

13109 ON THE REDUCTION AND PREVENTION OF THE GENERALIZED AND LOCAL REACTION TO RADIOTHERAPY. M. Ch. Fajzullin, I. Ch. Galimov, and E. I. Cizova (Lenin Inst. for Advanced Medical Education, Kazan, USSR). Radiobiol. Radiother., 3: 437-44(1962). (In German)

A total of 101 patients with diseases of the central nervous system, such as multiple sclerosis, syringomyelia, and midbrain syndrome, were irradiated with 180-kv x ray at a rate of 23 to 34 R/min, with total doses of 75 to 150 R per treatment. After the first or second irradiation, when a generalized radiation reaction began to appear, the patients were given intravenous injections of 5 ml of 5 to 10% NaBr solutions. Generally, these were administered the night before the next irradiation, but 11 patients received the treatment ~1.5 to 2 hr before the irradiation. This treatment prevented subjective symptoms of the irradiation. The blood Br concentrations varied most widely in the most disturbed and excitable patients. Presedation was required for some of the patients. The Br turnover in blood appeared to be related to the reactivity and functional changes in the activity of the nervous system. In 49 patients with malignant tumors of the pharynx or paranasal sinuses local reactions to radiotherapy of the mucosal tissues were prevented by local application of 5% Novocain, to which adrenaline had been added in a ratio of 1:1000. This permitted higher dosages of radiation to be used than would have been possible otherwise. They received 200 to 250 R to a single field, with total doses from 3000 to 6000 R. A few of the patients were irradiated by a ^{60}Co source. The prevention of local radiation reactions was believed to be related to effects of altered tissue permeability at peripheral nerve endings. (BBB)

13110 PRELIMINARY REPORT OF RESULTS WITH OXYPHENBUTAZONE (TANDERIL) IN X-IRRADIATED PATIENTS WITH TUMORS OF THE ORAL CAVITY, PHARYNX, AND LARYNX. U. Cocchi (Kantonsspital, Zurich). Radiol. Clin., 32: 372-8(1963). (In German)

Because of malignant tumors of the oral cavity, larynx, and pharynx 96 patients were treated with conventional x-ray or megavolt therapy. The poor physical condition or extensive spread of the tumor prevented any treatment of 40 of these patients with drugs. Of the other 56, 26 received Tanderil, the monohydrate of 1-phenyl-2-(p-hydroxyphenyl)-3,5-dioxo-4-n-butylpyrazolidine. The other 30 patients were not treated with Tanderil and served as a control group. Ambulant patients were not given medication because it was difficult to ensure that the required procedures would be carried out. Tanderil capsules were given in three 100 mg doses each day (3 × 1). In a few cases larger initial doses of 2 × 2 or 2 × 3 capsules are given. A total of 61 capsules was given in 26 days. Only 2 patients received Tanderil suppositories of 250 mg (2 per day). Treatment had to be halted in 5 patients because of worsening of their physical condition, but it was resumed after an interval of 2 weeks to 2 months. Tanderil was used for treatment of edematous, reddened radiation burns that had been produced by treatment with 2000 to 4500 R. Three patients were given Tanderil prophylactically before burns appeared. Seven patients were given Tanderil immediately after irradiation, one received a prednisone supplement, and one received a penicillin injection. Changes in the blood picture seen in the control group were not observed in the treated group. In 16 patients difficulty in swallowing was improved. When Tanderil was administered after the radiation reaction had already started, the mucosal reaction was not altered. The only side-effect observed was gastric symptoms in one patient. (BBB)

13111 CLINICAL EXPERIMENTATION WITH A NEW DERIVATIVE OF THE PHENOTHIAZINE SERIES (BUTYRYLPERAZINE) IN GENERAL MEDICINE. G. Colao and R. Scardino (Ospedales S. Gennaro, Naples). Riforma Med., 77: 564-6(May 25, 1963). (In Italian)

Megalectyl or butyrylperazine (N-[α-4-methylpiperazine-1′ propyl]-3-butyrylphenothiazine) was tested clinically on 70 patients (36 males, 34 females) with various diseases, eight of whom suffered from radiation disease after x-ray therapy. The patients with radiation illness had been treated for the following neoplastic lesions: mammary cancer recurrence after mastectomy, three patients; uterine cancer, two; and one each of ovarian and lung cancer. Added to this group were two Hodgkin's disease patients who first were treated with cytostatic drugs followed by

x-ray therapy. Megalectyl treatment improved the side-effects of radiotherapy in all patients, permitting continuation of the ratiotherapy until completion of the course of treatment. The cytostatic drug side-effects were also alleviated. Signs of intolerance or disturbances in various organs were never observed. Disappearance of vomiting and reduction of nausea were observed in the patients suffering from radiation illness and in pregnant women as well. The drug was also tried with good results as prophylactic medication and on other cancer patients undergoing radiotherapy. The drug was given rectally in suppositories of 2.5 mg each, four to six a day, and orally in tablets of 1 mg, from one to two up to a maximum of four tablets a day. (BBB)

13112 CLINICAL STUDIES OF SIA EFFECT UPON LEUKOPENIA INDUCED BY X-RAY THERAPY FOR CANCER OF THE CERVIX. Tomoyuki Furuta, Satosi Kawamura, and Tamotsu Shimizu (Kyoto Univ.). Sanfujinka no Shimpo, 15: 357-60(Nov. 1963). (In Japanese)

Radiotherapy frequently induces leukopenia in cancer patients. To counter this, leukocytosis-promoting agents (SIA) may be used. One such agent, 2-α-carbethoxybenzyl-4-carboxythiazolidine, was tested for its therapeutic effect in 22 cervical cancer cases, with six patients as controls. A dose of 120 mg/day (in 3 divided doses) was administered during the x ray therapy to total doses of 4000 R, while various blood tests were made. The six irradiated control cases showed a marked decline in leukocyte count (average 29%) after 1000 R, and a decline of 54% after 4000 R. Eight (36%) of the experimental cases were regarded as responding favorably by showing a decrease of only 15% on an average at 1000 R, and 34% at 4000 R. The mode of decrease was not uniform among the individual cases. Another eight experimental cases were grouped as showing a considerably effective response, since they showed an average decrease of 20% at 1000 R and 38% at 4000 R, a much better picture than in the control groups. The mode of decrease was somewhat more regular. The last six experimental cases were considered as having an ineffective response, since they showed a decrease of 54% at 4000 R, not far from the control group. Other blood tests showed no alterations and no severe side-effects were observed because of drug administration. (BBB)

13113 AUXILIARY MEDICAL TREATMENT OF TUMOR BEDS. PART VIII. EXPERIMENTAL ANIMAL INVESTIGATIONS ON THE QUESTION OF PARATUMORAL AND TUMOR DISTANCE NICOTINIC ACID EFFECTS ON THE CROCKER SARCOMA 180 UNDER OPTIMAL X-RAY IRRADIATION. Gunther Barth, Herbert Graebner, and Marianne Winter (Universitat, Giessen, Ger.). Strahlentherapie, 126: 70-86(Jan. 1965). (In German)

In addition to radiation therapy, 370 heterozygous male mice received treatment of the tumor bed with nicotinic acid in a 48-hr cycle. The results showed, that the Crocker-sarcoma 180 used will improve, only if the paratumoral treatment is done during x irradiation. Nicotinic acid administered parenterally and distant from the tumor, shows no influence upon the tumor growth during x irradiation. Therefore, a protracted increased oxygen supply is not present at the tumor bed and, hence, the radiation sensitivity of the tumor is not greatly increased. It is, therefore, not recommendable to use this substance in addition to radiation therapy. (auth)

13114 POSSIBILITIES OF THE ACTION OF SENSITIZING AND DESENSITIZING SUPPLEMENTS IN RADIATION CHEMISTRY AND BIOLOGY. PART VI. THE INFLUENCE OF IRRADIATION ON TUMOR FORMATION AFTER 3,4-BENZOPYRENE. Ruprecht Koch and Guenther O. Schenck (Universität, Freiburg i. B. and Max-Planck-Institut für Kohlenforschung, Mulheim, Ger.). Strahlentherapie, 126: 87-93(Jan. 1965). (In German)

The influence of ionizing radiation on the carcinogenesis in mice after administration of 3.4-benzopyrene was investigated. Subcutaneous injection of 3.4-benzopyrene, followed by total-body irradiation with 50, 100, or 200 R or even irradiation with 200 R prior to the injection did not result in significant changes of the rate of tumor formation or of the average incubation time. Hence, the process of chemical carcinogenesis is influenced neither biologically nor radiation-chemically by irradiation. The same result is obtained in case of a local ^{198}Au irradiation or in charcoal particles are added to the oily solution of 3.4-benzopyrene, or if the hydrocarbon is embedded into gelatin before application. The carcinogenic effect of 3.4-benzopyrene decreases significantly if the hydrocarbon is irradiated in vitro with x rays whereas uv irradiation is without effect. The inhibition of carcinogenesis is attributed to quinones which may have been formed via radiation-chemical relay mechanisms. (auth)

13115 INFLUENCE OF METANDROSTENOLON ON THE GAS METABOLISM DISTURBANCE DURING SUB-ACUTE RADIATION SICKNESS. Andrzej Danysz, Ryszard Panek, and Henryk Proniewski (Pharmakoligische Institut, Medizinische Akademie, Bialystok, Poland). Strahlentherapie, 126: 105-10(Jan. 1965). (In German)

The influence of Metandrostenolon on gas metabolism by young and adult rats before and after irradiation with sublethal doses of x rays was studied. Chronic administration of Metandrostenolon in the dose of 1 mg/kg caused significant increase of the body weight and the inhibition of gas metabolism. Irradiation of young rats which received Metandrostenolon caused no disturbances in the O_2-consumption and CO_2-excretion. The irradiation of adult rats after Metandrostenolon administration causes a deepening of the characteristic inhibition of O_2-consumption. The results indicated a radioprotective effect for Metandrostenolon in relation to gas metabolism by young rats and in relation to leukocytosis and body weight as well by both young and adults rats. (auth)

13116 WHAT THE SANITARY OFFICER SHOULD KNOW ABOUT A-WEAPONS. Werner Isler (Universität, Zurich). Vierteljahrsschr. Schweiz. Sanitaetsoffiziere, 40: 97-111(Aug. 1963). (In German)

Treatment of radiation injuries that may result from atomic explosions is discussed. It is proposed that each soldier should be provided with an individual dosimeter to record the amount of radiation that could have been received. In the treatment of acute radiation syndrome the patient should have complete physical and mental rest. Sedatives may have to be administered, but barbiturates should be avoided. Personnel suffering from radiation injuries should never be designated as ambulatory wounded. In order to reduce shock, plasma or plasma expanders should be administered. Large amounts of fluid should be avoided in view of the increased vascular fragility. Except in cases where large amounts of blood have been lost, blood transfusions should not be given during the first two weeks because there may be a tendency toward severe immunological reactions. Antihistamines may help to reduce shock symptoms. Usually cortisone should not be administered because it reduces resistance to infection. Antibiotics should not be administered prophylactically before indications of infection because of the hazard of selection of resistant strains of microorganisms. Antibiotics are indicated only during a phase of extreme fever or the appearance of ulcerations and inflammation. Sulfonamides should be used with extreme caution. Personnel with radiation injuries should be isolated from infection by scrupulous nursing care. When gastrointestinal symptoms appear, infusions of NaCl-glucose, amino acid mixtures, and vitamin supplements, should be given. Diarrhea may be controlled by a pectin diet. If there are gross spasms, atropine should be given. If surgical intervention for wounds is necessary, local anesthesia or nitrous oxide with a small amount of ether should be used, and if possible chloroform should not be given. (TCO)

13117 CLINICAL STUDIES WITH VOYAL IN RADIATION INTOXICATIONS. Karl Brennig (Sonderabteilung fur Strahlentherapie des Krankenhauses der Stadt Wien-

Lainz, Vienna). Wien. Med. Wochschr., 113: 647-8 (Aug. 31, 1963). (In German)

The intensive x-ray treatments used for gynecological radiotherapy often result in a syndrome that has been designated as an x-ray catarrh. The symptoms include dizziness, nausea, and vomiting, and result from disturbances of the autonomic nervous system. The duration and severity of the symptoms depend on the total volume dose of x ray administered, the sensitivity of the patient, and the individual sensitivity of the tissue irradiated. The use of Voyal, the chlorotheophylline acid salt of diphenhydramine for treatment of these symptoms is described. Voyal prevents nausea and vomiting by direct suppression of stimulation of the brain stem and labyrinth. Because it has a direct action on the vomiting center it can be used for both therapeutic and prophylactic effects. It is completely absorbed when administered orally or rectally. A total of 73 patients were treated with Voyal. They were given two capsules rectally, one 2 or 3 hr before, and one just previous to the radiation treatment. Treatment with Voyal prevented x-ray catarrh in all except 4 patients. No greater dose was necessary, and side-effects were not observed even in cachectic patients. (TCO)

13118 TIME STUDY OF OXIDATIVE PHOSPHORYLATION IN RAT LIVER MITOCHONDRIA FOLLOWING WHOLE BODY IRRADIATION, AND THE EFFECTS OF VARIOUS HORMONES THEREON IN VITRO AND IN VIVO. Allan Leonard Goldstein. Thesis, New Brunswick, N. J., Rutgers Univ., 1964. 89p.

Liver mitochondria were isolated in isotonic sucrose-Versene from rats exposed to a single dose of 840 R of whole body x irradiation at 1, 3, 6, 12, 24, 48, and 72 hours prior to sacrifice and from sham-treated controls. Oxidative phosphorylation, protein content, number of mitochondria, and blood glucose levels were recorded. P:O ratios were significantly reduced three to twelve hours after irradiation with pyruvate, β-OH butyrate, citrate, and glutamate as substrates. The ratios returned to normal levels within 24 hours in most cases and by 48 hours in all. The effects of insulin, growth hormone, cortisone, and cystamine were added in vitro and in vivo in the 3-hour irradiated group with pyruvate and citrate as substrates. In the 3-hour irradiated animals, P:O ratios fell with pyruvate and citrate. Blood glucose levels rose by 40%. There was a slight fall in total mitochondrial protein and number. Mitochondria from irradiated animals were very fragile and more variable in size. Insulin added in vitro completely restored P:O ratios to normal levels. Growth hormone and cortisone were equally effective in vitro. Insulin, growth hormone, or cortisone injected in vivo completely restored P:O ratios to normal levels. Cystamine had no restorative effect on P:O ratios with either substrate in vitro or in vivo. Insulin, growth hormone, and cortisone, injected one hour before sacrifice, each reduced blood glucose levels by 65%, 23%, and 20% respectively while cystamine was ineffective. It is postulated that insulin plays an important role in maintaining the proper integrity of the mitochondrial membrane and that the reduction in phosphorylation efficiency following whole body irradiation may be due to a change in the amount of active insulin available. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13119 INFLUENCE OF TONICITY ON MITOTIC RECOVERY IN X-IRRADIATED GRASSHOPPER NEUROBLASTS. Herman Matthew Meisner. Thesis, Atlanta, Emory Univ., 1964. 77p.

The effect of tonicity in modifying mitotic recovery from x rays was examined in hanging drop preparations of Chortophaga viridifasciata neuroblasts. The influence of other factors known to affect radiation damage, such as egg yolk, dinitrophenol, or change of pH, was studied at different tonicities. Embryos were cultured in either Carlson's inorganic salts-glucose medium or Shaw's amino acid-inorganic salts-glucose medium, and irradiated in vitro with 25 or 50 R, at 1 R/sec. A 10% decrease in tonicity depressed the mitotic ratio of irradiated (50 R)/non-irradiated cells 41% in Carlson's medium and 85% in Shaw's. The higher pH of Shaw's medium (7.0 compared to 6.2 in Carlson's) was responsible for the greater radiosensitivity of neuroblasts irradiated in hypotonic Shaw's medium. In hypertonic solutions, the difference in pH had no effect on the mitotic ratio. Addition of egg yolk to grasshopper neuroblasts enhanced the mitotic ratio of irradiated/non-irradiated cells, the effect becoming less pronounced as tonicity was increased. After 25 R, the mitotic ratio of neuroblasts cultured in hypotonic Shaw's medium was increased by 2,4-dinitrophenol. It was suggested that irradiation results in a greater utilization of ATP, which is enhanced by hypotonicity and depressed by uncouplers of oxidative phosphorylation such as DNP. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13120 ON THE MECHANISM OF ACTION OF S-CONTAINING PROTECTIVE AGENTS. Lorentz Eldjarn (Universitet, Oslo). 21p. (CONF-456-7)

From 18th Annual Symposium on Fundamental Cancer Research and Cellular Radiation Biology, Houston, Tex., Mar. 1964.

Basic ideas concerning the mechanisms underlying the pharmacological and radioprotective activity of the sulfur-containing protective agents are discussed and some recent results are reviewed. The search for target molecules of cell nuclei are briefly considered. Four radiochemical mechanisms are considered as explanation for the in vivo protection by the compounds of the cysteine-cysteamine group. These include: the radical scavanger hypothesis; repair of ionized target molecules by hydrogen transfer reactions; anoxia hypothesis; and the mixed disulfide hypothesis. It was concluded that S-containing agents demonstrate a favorable localization to cells and tissues of particular significance in the development of radiation syndrome. (P.C.H.)

Radiation Hazards and Protection

13121 (AERE-L-151) HEALTH PHYSICS ASPECTS OF PLUTONIUM HANDLING. A Series of Lectures Given During a Visit to Japan, March 1964. B. A. J. Lister (United Kingdom Atomic Energy Research Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1964. 204p. Dep.; $8.00 (BIS); 40s. (HMSO).

A series of lectures on health physics aspects of plutonium handling is presented. Topics discussed include the properties of Pu, hazards, and general methods of control, Pu containment, Pu monitoring, Pu metabolism, excretion, and bioassay, in vivo measurement and treatment of internally deposited Pu, criticality control in Pu areas, and emergency procedures and experience in Pu areas. (C.H.)

13122 (JPRS-27535) PROTECTION AGAINST RADIATION AND DOSIMETRY. Aleksey Alekseevich Moiseev and Viktor Ivanovich Ivanov. Translated from p.28-54; 96-101; 164-75; 182 of "Kratkii Spravochnik po Radiatsionnoi Zashchite i Dozimetrii," Atomizdat, Moscow, 1964. 62p. (TT-64-51784). $3.00(OTS).

Translations are presented of three chapters from this Russian-language book. The chapter titled Radiation from Natural Sources discusses cosmic radiation, natural radioactivity of the environment, and natural radioactivity in plants and food products; the chapter titled Radiation Dosages for Various Human Organs and Tissues presents generalized data on the doses of natural radioactive isotopes contained in rock, soil, air, and man, and includes data on the radiation doses experienced by man during radiotherapy and radiodiagnosis; the chapter titled Content of Certain Stable Elements within Objects in the Environment and in the Human Organism presents data on the chemical composition of dry residue of atmospheric precipitation, of river and lake waters of various regions of the USSR, of soil samples, and of green plants, cereals, fruits, vegetables, milk, and other foods. Data are included on the content of K, Ca, and stable Sr in human organs and tissues and

the human consumption of Ca and stable Sr with various food products. (C.H.)

13123 HYGIENE AND SURVIVAL OF THE CIVILIAN POPULATION IN MODERN WARFARE. S. Freni (Scuola di Sanita Militare, Rome). Giorn. Med. Mil., 112: 241-58 (May–June 1962). (In Italian)

In Italy, in spite of warnings from authoritative sources, the response of civil population to fallout shelters has not resulted in the proper participation. The immediate heat, blast, and radiation effects are estimated for a one-Mt nuclear device: a crater with a dia of 198.2 m and depth of 42.6 m, with houses collapsing within a radius of 4.82 km, fires developing within a radius of 14.5 km, traumatic lesions due to flying debris occurring in an area of 75.5 km^2, acute irradiation exposure (700 rem) extending to a radius of 2.4 km, and heavy fallout covering an area of 518 km^2. Any fallout shelter presumably must give ample security for three to fourteen days and must take into consideration penetration of radioactive dust, emergency illumination, refuse disposal, and so forth. Unlike the situation after the last war, it will be impossible to provide a sufficient water supply due to the fallout contamination of most water sources. After the population leaves the destroyed cities and concentrates in zones free of tropospheric fallout, characteristic hygienic problems will appear. Postwar problems will include: radionuclide saturation of the available living space, incomplete protection from weather, insufficient clothing, damaged heating systems, insufficient general hygienic services, inadequate personal hygiene due to mass inertia and indifference, and easy diffusion of disease-vector parasites with poor sewage disposal. This will be aggravated by the dissimilarity of the cultural and educational background of survivors and the necessary dissimilar medical assistance accentuated by problems of collective living. Feeding the survivors will depend upon the available means of decontamination and use of noncontaminated food to assure a daily diet of at least 1800 to 2000 cal. Children, adolescents, pregnant and nursing women, and persons with special diets will pose additional problems. The various proposed decontamination procedures which principally are those of traditional biological and chemical purification methods cannot always be considered completely safe in their practical application. Problems relating to disease are also discussed. The main diseases expected to be encountered are: respiratory infections, salmonellosis, shigellosis, and forms of mycotic and parasitic cutaneous diseases. It is possible that the classical plagues may reappear in Italy. Defensive measures will require isolation of affected persons, rapid diagnosis of the disease, with rapid and simple use of identification techniques, such as fluorescent antibody and infrared spectrophotometry tests. Hospitals will need the availability of large supplies of various equipment, medical apparatus, vaccines, serums, antibiotics, and chemotherapeutic agents. There is a necessity for auxiliary health personnel, of whom there is still a great scarcity in Italy. The level of hygienic-medical education attained by the population will be a decisive factor, and only through mass education of modern disease preventive measures can this problem be resolved. (BBB)

13124 SYMPOSIUM ON SOME USES OF IONIZING RADIATION IN PREGNANCY. I. THE THERAPEUTIC AND DIAGNOSTIC USE OF RADIOISOTOPES DURING PREGNANCY. R. J. de Groot (Cancer Inst., Melbourne). J. Coll. Radiologists Australasia, 8: 123-7(June 1964)

Hazards of the therapeutic use of radioisotopes in pregnancy are discussed, particularly the risks that might be associated with their use in the first trimester, when the patient may be unaware of pregnancy. A policy of administering radioisotopes to women of child-bearing age only when the absence of pregnancy is practically certain is advocated. Some diagnostic tests are considered and suggestions made for reduction in dosage. The use of ^{132}I is strongly recommended, not only for thyroid uptake tests, but for labeling the iodinated compounds used in many other investigations. After the third month, the normal thyroid uptake test using ^{131}I entails a fetal thyroid dose in the range 0.089 to 5.3 Rad/μC ^{131}I administered to the mother. The dangerously high upper limit of this dose range is not generally appreciated. With the short-lived ^{132}I (T = 2.26 hr) the fetal thyroid dose is reduced about one-eightieth. The use of ^{125}I is another possibility. With this isotope the radiation dose can be reduced by a factor of 16 compared with ^{131}I. Other approaches to the problem of reducing the dosage in thyroid tests in pregnancy are discussed. In vitamin B_{12} studies, very little radioactive material, usually less than 1 μC of ^{58}Co, is used. The radiation dose to the mother would be less than 500 Mrad, and the dose to the fetus less than this. Plasma volume studies using ^{132}RISA in small quantities would deliver a negligible dose to the fetus and should be acceptable. Red cell volume studies using ^{51}Cr, which is purely γ-emitting isotope, should be safe. Fetal irradiation from 25 μC of ^{51}Cr would be less than 20 Mrad. Extensive hematologic tests using ^{51}Cr or ^{59}Fe are not desirable. Some new developments that would lower fetal doses in diagnostic tests are the use of ^{3}H-labeled compounds, low background shielded chambers for very sensitive whole-body counting, and neutron activation analysis. (TCO)

13125 SYSTEMATIC RADIOLOGIC EXAMINATION OF THE THORAX AND COMPARATIVE GONADAL DOSES. J. Valeyre and R. Dutruel. J. Franc. Med. Chir. Thorac., 17: 457-63(May-June 1963). (In French)

Radiologic methods for examining the thorax are: radiography, radiophotography, and fluoroscopy. Measurements were made of doses to the gonads with these three methods to determine their relative harmfulness to the thorax, where it is difficult to obtain accurate dosimeter measurements. The gonads were studied because they are critical organs and the gonadal dose would be proportional to the total absorbed dose. A voltage of 83-kv was used with all three techniques. A second series of measurements was made on a phantom as similar as possible to a human body in terms of absorption and scattering of the radiation. Radiographic examination of 400 men and 2000 measurements on the phantom revealed an average gonadal dose of 17 and 18, respectively (arbitrary units). Fluoroscopy of 150 men delivered a gonadal dose of 55. The same technique used on the phantom 1000 times delivered a dose of 60. Radiophotography on 160 men gave a dose of 330. On the phantom 420 examinations gave an average gonadal dose of 220. Radiophotography delivered a gonadal dose 10 times greater than radiography. Fluoroscopy delivered a dose four times greater than radiography. The total absorbed dose in fluoroscopy was always greater than in radiophotography, but it was not directly proportional to the gonadal dose. For all three methods the gonadal dose was between 10 and 300 Mr. These results were for radiophotography in a 7 × 7 cm format and radiography on films of high sensitivity. It was concluded that there is no significant hazard to men from a radiological examination given under optimal conditions, that is: brief irradiation time, limited exposure field for sharper image and less radiation scattering, current intensity below 3 ma, high sensitivity film, and a filter to reduce the absorbed dose. (BBB)

13126 THE MANAGEMENT OF RADIATION CASUALTIES. Paul From. J. Iowa State Med. Soc., 52: 406-9(July 1962).

The creation and stockpiling of nuclear weapons introduce the possibility that, sooner or later, accidentally or intentionally, some of them may go off, and physicians must assist in making realistic preparations for such occurrences. An estimate of the number of casualties which might occur is impossible because of the number of variable factors involved: type of burst, type of construction of the city, season of the year, density of population, time of day the detonation occurs, and magnitude of the detonation. A thermonuclear device can cause casualties by three principal means: blast, thermal burns, and radioactivity, which would vary in importance according to the three methods of detonation (in the air, on the ground, or in

water). The following are the types of casualties resulting from the bombing of Hiroshima and Nagasaki: blast effects (direct and indirect); burns (flame burns and flash burns); effects of radiation energy on the eye (including development of cataracts); keloid changes; pigmentation and depigmentation due to uv rays; radiation injury, primarily from the effects of γ rays and neutrons; delayed radiation effects from β rays and α particles emitted by the fission products immediately after the explosion; and residual radiation effects. The effects of radiation are described in detail. In the event of a blast, all permanent facilities in the area will disappear, and all trained personnel and supplies will be destroyed. The area will be inaccessible for 14 days or more and anyone surviving and not protected from radiation will develop radiation sickness. Therefore, protection in areas where fallout pattern could extend for hundreds of miles should be emphasized. Passive protection implies remaining in the contaminated area but taking all possible shelter, particularly from γ rays emitted by the fission products in the fallout, considering that the rays can travel only in a straight line and can be absorbed or stopped only by massive shieldings. Active protection, implying evacuation to a safe area, is not feasible. Decontamination after the fallout has settled is important, but the procedures are extremely hazardous since they involve exposure of the operating personnel to fairly high levels of radiation. After thermonuclear attack, everyone must seek shelter immediately and remain there for at least 14 days. Hospitals should stock food and water to carry them through the critical period, and plans must be made for decontaminating anyone entering the hospital area. If radiation-syndrome casualties are found, it should be ascertained if a lethal dose of radiation has been experienced, and attention given only to those likely to survive. (BBB)

13127 GAMMA-RAY EXTERNAL DOSES FROM FALLOUT FISSION PRODUCTS DEPOSITED ON GROUND DURING THE PERIOD FROM 1958 TO 1963. V. Havlovic and V. Santholzer (Charles Univ., Hradec Karlove, Czechoslovakia). Kernenergie, 7: 773-6(Nov. 1964). (In German)

The methods of determining gamma-ray external dose rates from fallout fission products deposited on ground after nuclear tests are described. One of these methods has been applied for evaluating the dose rates from external gamma radiation on the basis of long-time fallout measurements of Hradec Králové/Č.S.S.R. The radiological doses received by the population from external gamma radiation of fission products deposited on ground since the first test stopping from November 1958 to December 1963 are rather low and form a small fraction of the gamma-ray natural body burden of terrestrial or cosmic origin. Some limiting factors for determining the results obtained are discussed. (auth)

13128 STUDY ON SCATTERED RADIATION. PART I. MEASUREMENT OF EFFECTIVE VOLTAGE OF SCATTERED RADIATION BY THE HALF VALUE LAYER METHOD AND ROTATING HALF VALUE LAYER METER. Junnosuke Matsuoka and Seiichi Yoshimoto (Kyushu Univ., Fukuoka). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 44-50(Apr. 1962). (In Japanese)

For measurement of the effective voltage of scattered radiation the half value layer method was used with aluminum sheets of various thickness. Under usual fluoroscopic conditions for examination of upper gastrointestinal tract (70 kvp, 3 ma, filter 1.0 mm Al, F.S.D. 50 cm) measurements with a 20-cm thick acrylite phantom (16 × 12 cm beamsize on the screen at a 70 cm distance from focus) gave an effective voltage of scattered radiation of between 20 and 50 kv at the lateral edge of the fluoroscopic table and about 20 kv at 50 cm from the edge. For this calculation, a half value layer effective voltage chart is described. This result is close to the value obtained with a scintillation pulse height analyzer. Increasing the thickness of the acrylite phantom in the radiation path made the effective voltage of the penetrating radiation higher. A rotating half value layer meter was designed for easier determination of effective voltage. Geometrical aspects of measurement of voltage of scattered radiation by the half value layer method are discussed. (TCO)

13129 RADIATION SAFETY. A RADIOISOTOPE ACCOUNTABILITY SYSTEM. R. E. Ogborn and Glen B. Eich. Radiol. Technol., 35: 198-200(Nov. 1963).

A record keeping system, to account for receipt, use, and disposal of radioisotopes, in accord with U. S. Atomic Energy Commission regulations is presented. This system has proved highly effective, yet not cumbersome to manage; simplicity and accuracy are its main features. A single entry method is used, with a ledger as the detailed record and a consolidated record. Each isotope is identified by name, lot number, assay, and date of assay. The day the isotope is received, information from the container label is recorded in the ledger and in the consolidated record as of that date, as explained here in detail. This label or a copy thereof is filed by the date of assay for future reference. Three types of entries are made in the ledger: receipt, usage, and disposal. The first entry represents the receipt of the isotope and the date it is received. The second type of entry is recorded the same day any portion of the isotope is used. The date is placed in one column, in other columns the patient's name, the name of the test or experiment, the amount in millicuries used, and the amount in milliliters withdrawn. In each entry the total of one column subtracted from the previous entry in the column reveals the amount of decay, which is entered. It is possible to know at all times the amount on hand, the millicurie strength of that amount, and the total amount of decay which has occurred from the date of receipt to the date of the last entry. This enables more effective utilization of radioisotopes. The third type of entry indicates the remaining amounts after disposal, as well as the date. A consolidated record is maintained wherein a separate sheet is kept showing the total amounts received, used, and decayed for each radioactive material. The total amount of money spent for a specific isotope is also computed. The first entry in the consolidated record is made simultaneously with the first entry in the ledger with the name of the isotope, lot number, date received, and the total amount in millicuries received. When appropriate, the ledger account is closed, and the total amounts of millicuries used are then transferred to the consolidated record. Stock levels of isotopes are determined by considering the information in the consolidated record. Needs can then be easily anticipated. These records must balance with the disposition records maintained by the health physicist. The consolidated record offers a review of the complete history of each isotope in the lab. This plan is equally adaptable to labs preparing their own isotopes. This system of radioisotope accountability has been utilized for 22 months, and because of its use it was possible to accomplish a 44% increase in the number of studies while using only 49% of the radioisotopes formerly used under another accountability system. (BBB)

13130 MEDICAL EFFECTS OF NUCLEAR WEAPONS. Edward Marks (Brooke Army Medical Center, Fort Sam Houston, Tex.). Texas State J. Med., 60: 15-22(Jan. 1964).

When a nuclear weapon is detonated, the energy is released in a short time in a limited space, and is distributed in the form of blast, heat, and nuclear radiation. About half of the energy is in the form of blast, 35% as heat and light, and 15% as ionizing radiation. Associated with each of these physical effects of a nuclear detonation are different types of injury to be expected. From blast, mechanical injuries such as fractures and lacerations are similar to those caused by conventional bombs, except for the larger number and variety of injuries suffered in a short interval of time in the case of a nuclear explosion. From thermal radiation, flash and flame burns, retinal burns, and flash blindness are produced. From ionizing radiation, the only effects completely absent from conventional explosions are the deep cellular and tissue injury and beta burns produced. The nature of blast injury is discussed. The vulnerability of personnel to thermal radiation is indicated in a table, which shows the ranges from ground zero on a clear day

over which second degree burns may occur to exposed personnel from three weapon yields. The diameter of the fireball for a 10-Mt weapon is about 3.5 mi, with complete destruction within this range. Persons unable to take evasive action would sustain second degree burns on unprotected skin at a distance of ~24 miles from ground zero (9.2 cal/cm^2). Various aspects of injuries produced by ionizing radiations are discussed, including the influence of dose, dose rate, and type of radiation. (TCO)

13131 AN ARRANGEMENT FOR THE MEASUREMENT OF SMALL THORON CONCENTRATIONS IN THE AIR. Rudolf Grillmaier, Hermann Muth, and Erich Oberhausen (Saar Universität, Homburg, Ger.). Z. Angew. Phys., 18: 112-14(Dec. 15, 1964). (In German)

The construction and calibration of apparatus for measurement of the thoron concentration in expired air of persons with thorium depositions is described. Because of the special purpose of the apparatus, when the measured value must be representative for exhalation under normal conditions, specific specifications must be met, and these are discussed. A comparison of the values measured in the calibration was made with theoretically calculated values, and the agreement was satisfactory. (tr-auth)

13132 CONTRIBUTION TO THE QUESTION OF THOROTRAST INJURY AFTER RETROGRADE PYELOGRAPHY. W. Hartig and J. Neideck (Kreiskrankenhaus, Borna, Ger.). Z. Urol., 56: 249-68(May 1963). (In German)

Several forms of Thorotrast deposition in kidney have been observed after retrograde pyelography. Deposited Thorotrast can produce malignant tumors because it is radioactive, but the nature of the cause and effect relation is not known. Three cases of kidney tumors or kidney damage caused by Thorotrast deposition are reported. The first was a 58-yr-old man who had received Thorotrast 20 yr previously during retrograde pyelography. He had a metastatic cornified squamous cell epithelioma of the right kidney. After nephrectomy the patient died. The second case was 52-yr-old and had received Thorotrast for retrograde pyelography 32 yr previously. After nephrectomy of the right kidney multiple deposits of Thorotrast were found in the immediate area of the upper kidney calyx, but there were no evidences of malignant growth or inflammatory reactions. The third case was a 64-yr-old patient, who had also received Thorotrast during retrograde pyelography. After removal the right kidney was found to be extensively infiltrated with Thorotrast. A carcinoma was found with its primary site in the kidney pelvis. (TCO)

13133 RADIATION SAFETY PROCEDURES FOR NURSES. (Alabama, Univ., University. Radiation Control Office). [196?]. 18 p. (Free, Radiation Safety Office, Univ. of Alabama).

Radiation protection procedures are presented for the guidance of nurses engaged in the care of patients during radiotherapy or radiodiagnosis. (C.H.)

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Refer also to abstracts 13766, 13792, and 14186.

13134 (NP-14426) IZUCHENIE PROTIVOOPUKHOLEVOGO DEISLVIYA RADIOAKTIVNOI METILENOVOI SINI MECHENNOI PO SERE (^{35}S). (Studies of Antitumoral Effects of Radioactive Methylene Blue Labeled with Sulfur (^{35}S)). N. A. Vodolazskaya and V. N. Zaitseva (U.S.S.R.). [1956]. 8p. Dep.(mn).

An attempt was made to determine the combined chemotherapeutic and antitumoral effects of ^{35}S-labeled methylene blue. The hydrobromide of ^{35}S-labeled methylene blue phenothiazine bis(dimethylamino) with a specific activity of 13.5 to 95.5 mC/r did not exhibit any direct effects on Ehrlich tumors. However, treatments with high-activity methylene blue prolonged the life of animals injected with lymphosarcomas twofold over that of control animals. (R.V.J.)

13135 (NP-14630) MÉTHODES DE CONTROLE DES RADIOÉLÉMENTS UTILISÉS EN MÉDECINE (THÈSE). (Methods of Control of Radioelements Utilized in Medicine (thesis)). Jose Bernard (Lyon. Université). [1962]. 84p. Dep.(mn).

Radioisotopes are used in medicine for diagnostic and therapeutic purposes. The control of contamination by these isotopes by the doctor using them is reviewed. A brief review is given of the principal physical properties of radioisotopes that permit the identification and control of these radionuclides. The nature and purity of a radioisotope can be controlled by its half-life decay period, radiation energy, and spectrometry. The methods used are described. The control of the total activity of the product and of the activity of each fraction prepared is discussed. In conclusion, the methods described are illustrated using ^{131}I and ^{32}P. (J.S.R.)

13136 RADIOISOTOPES IN THE DIAGNOSIS OF HEMATOLOGIC MANIFESTATIONS OF GASTROINTESTINAL DISEASE. John N. Bickers and Donald J. Sekinger (Louisiana State Univ., New Orleans). Am. J. Digest. Diseases, 9: 634-40(Sept. 1964).

The role of radioisotopes in the diagnosis of these disorders, using technics generally applicable in the average clinical radioisotope lab, are discussed. Detection of blood loss, or fresh bleeding, can be accomplished by tagging the patient's red cells with ^{51}Cr and measuring the stool radioactivity. This technic of red-cell tagging with ^{51}Cr can be extended to aid in the localization of a bleeding site. Folic acid deficiency can be inferred from the vitamin B_{12} absorption data; the basic technic for estimating vitamin B_{12} absorption is the Schilling test, which utilized the urinary excretion of the orally administered ^{58}Co- or ^{60}Co-labeled vitamin. In the presence of megaloblastic anemia, a normal Schilling test excludes vitamin B_{12} deficiency, leaving the inference that folic acid deficiency is present. The differential diagnosis of hypoproteinemia includes decreased production by the liver, loss through the kidneys, gastrointestinal tract and skin, and increased catabolic destruction. Renal loss is easily detected. Likewise, the presence of chronic liver disease, malnutrition, and severe infection, burns, or injuries are readily recognized. Under other circumstances, the etiology of hypoproteinemia may be less apparent, but relatively simple radioisotopic technics will clarify many of these. The simplest procedure is the determination of the ^{131}I-albumin biologic half life. If this is normal, it may be assumed that the defect lies in protein synthesis. If it is shortened, there is increased destruction or loss. Protein-losing or exudative enteropathy may be a manifestation of a variety of digestive-tract disorders, including hypertrophic gastritis, regional enteritis, and ulcerative colitis. Labeled ^{131}I-polyvinylpyrrolidone (PVP) is a reliable tracer in this condition, since it is secreted into the intestinal tract at a rate that tends to parallel protein excretion and remains intact, permitting quantitation of loss in the stool. (BBB)

13137 MORPHOLOGICAL ASPECTS OF VARIOUS RENAL NEOPLASMS AFTER X-RAY TREATMENT. M. A. Von Arx. Ann. Ital. Chir., 40: 289-97(1963). (In Italian)

This histologic study deals with tissue radiation responses in seven patients with renal tumors who were treated on alternate days with local doses varying from 50 R to 200 R, giving a total of about eight treatments prior to radical surgery. The tissue used for histological examination was taken from both the center and periphery of the tumor. Only a slight response of the neoplastic tissues to radiotherapy at the doses used was observed. Different results would have been obtained with more prolonged and intensive radiotherapy. The relatively infrequent degenerative changes in the tumor cells indicate the ineffectiveness of preoperative radiotherapy delivered at the doses used. (BBB)

13138 RADICAL SURGERY FOLLOWING RADIATION TREATMENT FOR CERVICAL CARCINOMA. John Stallworthy (United Oxford Hospitals). Ann. Roy. Coll. Surg. Engl., 34: 161-78(Mar. 1964).

Complications and histologic effects of irradiation are described with reference to 400 patients subjected to surgery and/or radiotherapy for cervical cancer. Injury to the ureters both by surgery and irradiation is a major problem. Early surgical technique called for complete isolation of the terminal two inches of ureter, which resulted in eight ureteric fistulae in 500 patients (1.6%). If the ureters after receiving about 3000 Rad were isolated earlier, necrosis seemed probable. For this reason, and because stripping it seemed unjustified, a new procedure was adopted. It was displayed crossing the common iliac vessels and lying on the lateral aspect of the posterior layer of the broad ligament. Then it was freed from the areolar tissue tunnel it occupies, without disturbing its blood supply, by making an incision above and parallel to it and dislocating it downwards. This could be done easily and with little trauma. With this modification of the surgical technique, three applications of radium were given according to the Stockholm technique with a total of about 7200 mg-hr over three weeks. The estimated dose was 3000 Rads at point A. Surgery six weeks after the first application, three weeks after the last, was little affected by the radiation. With a shorter interval, vascularity was increased. A longer interval did not increase operative difficulties, and surgery was performed safely for recurrent cancer years after the application of radium combined with deep x-ray or megavoltage therapy. When tissues become avascular, as happens months or years after extensive irradiation, minimal trauma is essential to reduce the incidence of fistulae. Ligature of the main vessels is omitted; because of extensive pre-operative irradiation every effort must be made to preserve blood supply, particularly to ureter and bladder. For a total of 285 postirradiation Wertheim operations performed (269 for cervical carcinoma and 16 for carcinoma of the corpus) there were two deaths, two ureteric fistulae, and five patients with bladder or rectal fistulae. Also described are the findings after a cancer confined to the cervix was exposed to lethal doses of radiation. Histological study of operative specimens established that these cancers vary considerably both in the rapidity and extent of their response to radiation. Within two months of the initial exposure the percentage of uteri with demonstrable residual malignant cells is related to the time interval, and six weeks after the first radium application is as high as 43%. Results of radiobiology studies suggest that the larger the tumor the greater the chance of malignant cells surviving, and this was confirmed by clinical and histologic experience. This would explain the excellent results of irradiation in early stage 1 carcinoma and the progressively poorer results with primary tumors of increasing size even in the absence of distant metastases. Whenever viable cells remain after irradiation, the prospect of cure is enhanced by removal of the uterus. This study showed that so-called cancer recurrence is not usually recurrence at all, but a survival and growth of the original tumor. Moreover, when this becomes clinically apparent in an area which has already been heavily irradiated, further radiation therapy carries grave risks and offers little hope. This establishes on a logical basis the role of postirradiation surgery. It was surprising that malignant cells were found in 43% of cervices, which received the maximum radiation dose, but in only 8% of the more remote parametrium, where the radiation effect would be less. Of a total of 401 patients seen with cervical carcinoma since 1950, 244 (61%) had postirradiation surgery, and 52% of all seen were alive and well five yr later and 71% of all operated on. Since 1954, 81 (57%) of a total of 141 and 64 (73%) of 88 who had combined therapy are alive and well five yr later. These results confirm the improved prognosis associated with the increasing use of the combined technique. (BBB)

13139 BOWEL OBSTRUCTION AFTER PELVIC AND ABDOMINAL RADIATION THERAPY: FACTITIAL ENTERITIS OR RECURRENT MALIGNANCY? James R. Shamblin, Richard E. Symmonds, William G. Sauer, and Donald S. Childs, Jr. (Mayo Clinic and Mayo Foundation, Rochester, Minn.). Ann. Surg., 160: 81-9(July 1964).

A description is given of 13 patients with intestinal obstruction after pelvic irradiation of sufficient severity to require surgical intervention. The cases are presented to emphasize the need for thorough study and a vigorous approach in an effort to distinguish those patients whose symptoms are due to recurrent cancer from those who have radiation damage. Bowel complications, usually stricture, from radiation therapy are variously cited as occurring in 1.6 to 16.9% of treated patients. Nine of the 13 patients described had a single stricture that involved the ileum in seven, the jejunum in one, and the rectum in one. In the remaining four patients, multiple sites were involved including stricture of the jejunum, ileum, and sigmoid in one, stenosis of the ileum and sigmoid in two, and actual necrosis of the ileum and sigmoid in one. The pathologic changes could be classified broadly into three phases: edema and hyperemia; ulceration; and formation of stricture. The earliest stage, that of acute inflammation with edema, hyperemia, and spasm, usually reached a maximum in three to four weeks after therapy and then subsided. However, it sometimes progressed to endarteritis and thrombosis of the vessels of the bowel wall causing mucosal infarction and ulceration of varying degree. The ulcer at this time may perforate into the abdominal cavity or into adjacent organs with formation of enteroenteric, enterovesical, or enterovaginal fistulas. If the ulcers heal, the resulting scar tissue may cause partial or complete obstruction of the lumen of the bowel. It was concluded that mild factitial damage to the bowel is common after pelvic or abdominal radiation therapy, and that such change may produce obstruction of the bowel and mimic recurrent carcinoma in every way. In these 13 cases of intestinal obstruction due to radiation damage, no specific diagnostic pattern was found, and abdominal exploration is the only reliable method of making a definitive diagnosis. (BBB)

13140 ONE-MERCURI-2-HYDROXYPROPANE (MHP): A NEW RADIOPHARMACEUTICAL FOR VISUALIZATION OF THE SPLEEN BY RADIOISOTOPE SCANNING. Henry N. Wagner, Jr., Irwin M. Weiner, John G. McAfee, and Jose Martinez (Johns Hopkins Univ., Baltimore). Arch. Internal Med., 113: 696-701(May 1964).

Synthesis of a new radiopharmaceutical and its advantages over the previously used method of spleen visualization using heat-treating ^{51}Cr-labeled cells are described. In the latter method, it is necessary to avoid heating the red cells excessively. Otherwise, the damaged cells accumulate in the liver as well as the spleen, since the hepatic reticuloendothelial system participates in the process of removing damaged red cells from the circulation. On the other hand, too little damage results in the failure of the spleen to remove the cells from the circulation. Similarly, the specific activity of the sodium chromate affects the degree of damage produced by heating the erythrocytes. With the new 1-mercuri-2-hydroxypropane (MHP) method, hepatic accumulation of the damaged red cells is not a problem. In addition, the procedure is simpler and requires much less time for both patient and technician. The technique consists of withdrawing several milliliters of blood from the patient, adding MHP labeled with ^{203}Hg or ^{197}Hg, and reinjecting the labeled red cells intravenously. The MHP-induced damage to the red cells results in their accumulation in the spleen, which then can be delineated by scanning techniques. Presumably MHP reacts with the protein sulfhydryl groups of the red cell, forming R-Hg-S-protein compounds. The possible radiation hazard was evaluated. Since the labeled red cells are promptly cleared from the blood, the total-body radiation is negligible. Nor is splenic radiation significant, since the radioactivity remains in the spleen for only a few hours. The limiting organ for radiation is the kidney; the urinary excretion of the radioactivity was at a nearly constant rate of about 0.5% of the dose per day. At least one quarter of the radioactivity appears in the stool, presumably the result of biliary ex-

cretion. It is estimated that the radiation exposure to a 150-g kidney from a dose of 100 μC of MHP-^{203}Hg is about 70 rad. The use of ^{197}Hg is preferable, since the radiation dose will thereby be reduced by at least one-tenth. When the latter material is used, the radiation dose to the patient is less than in many routine radiographic procedures. It is concluded that radiomercury-labeled MHP is a safe radiopharmaceutical for visualization of the spleen by radioisotope scanning. (BBB)

13141 SUCCESSFUL ALLOGENIC BONE MARROW TRANSPLANTATION IN MAN: CHIMERISM, INDUCED SPECIFIC TOLERANCE AND POSSIBLE ANTI-LEUKEMIC EFFECTS. G. Mathe, J. L. Amiel, L. Schwarzenberg, et al (Institut Gustave-Roussy and Institute Cancerologie et d' Immunogenetique, Villejuif, France). Blood, 25: 179-96(Feb. 1965).

A patient suffering from acute lymphoblastic leukemia in the third progressive phase, refractory to the majority of available treatments, was given total-body irradiation of 800 R, after administration of methyl-nitro-imidazolyl-mercaptopurine (300 mg daily for 4 days). One week after irradiation, he received an infusion of a mixture of equal parts of bone marrow from six donors (mother, sister, father and three brothers), a total of 5.8×10^{10} nucleated cells. Myeloid restoration began 2 weeks after the infusion and continued to progress rapidly. The reality of the graft was demonstrated by study of the erythrocytic antigens. Nearly all the erythrocytes found in the blood after 6 months belonged to the phenotype of one of the male donors. Studies of chromosomes and leukocyte sex chromatin suggested that a small proportion of leukocytes were being produced by the cells of one of the female donors. The patient was found to produce beta 2A, beta 2M and gamma globulins of the Inv type of the donors, suggesting that lymphoid cells may also have been successfully grafted. A skin graft from the male donor whose marrow graft had apparently been accepted was still perfectly intact 7 months after grafting, whereas the grafts from other donors were rejected, indicating a specific tolerance to tissues from this donor. Previous studies of compatibility between the recipient and the various donors by a histocompatibility test described by us, or by means of similarities in leukocyte antigens, indicated that the accepted donor had been antigenically more nearly compatible than the others. What appeared to be a secondary syndrome became manifest 1 week after marrow transfusion; it consisted of weight loss, digestive disorders (anorexia, nausea, vomiting, diarrhea), hepatic disturbances (hepatomegaly, increased serum concentrations of various enzymes), transient polyadenopathy (histologically composed of histiocytic proliferation and lymphocytic aplasia), desquamative erythrodermia, eosinophilia exceeding 50 per cent, and superinfection (including a probable miliary tuberculosis). The syndrome was controlled by careful symptomatic treatment; its intensity gradually abated. Reactivation of the secondary syndrome was accomplished by reinjection of leukocytes from the donor whose graft had been tolerated. This was controlled by Δ-1-cortisone and symptomatic treatment. The patient was still alive and in apparently complete hematologic remission from the leukemia 12 months after the treatment described above. Particular reason for this success possibly include the absence of previous blood transfusions and the use of multiple marrow donors. (auth)

13142 VALUE AND PLACE OF ^{131}I IN THE TREATMENT OF THYROID CANCER. M. Dargent, M. Berger, and B. Lahneche (Centre Leon Bérard, Lyon). Bull. Assoc. Franc. Etude Cancer, 50: 361-4(July-Sept. 1963). (In French)

Treatment of thyroid cancer with ^{131}I was evaluated on the basis of observation of 190 patients from 1950 to 1962. The ^{131}I was used almost exclusively for treating metastases, and only three times out of 190 in the treatment of the primary tumor. Therapy with ^{131}I was considered possible only when dealing with active or functional metastases, which present an avidity for ^{131}I as opposed to inactive or nonfunctional metastases which show no or very low avidity for the isotope. The possibility for isotopic treatment of early metastases is very rare and was possible in only three cases: two bone and one liver metastases. Fractionated doses were used: 30 μC repeated three to four times every 15 days, or one larger dose of 50 to 100 μC repeated, if necessary, three months later. In the case of inactive metastases treatment varies according to their potential for progressive development. When nonprogressive they are allowed to remain quiescent with the patient kept under constant supervision. This is particularly recommended in children and adolescents. When progressive, steps are taken to make them functional so as to enable success with ^{131}I therapy. Three different techniques were experimented with: (1) induction by endogenous thyrostimulation, (2) induction by exogenous thyrotropin (TSH), and (3) induction by fractionated doses of ^{131}I. Endogenous TSH induction was attempted following total or subtotal thyroidectomy and was achieved in 17 out of 63 patients. Total thyroidectomy was avoided because it was generally followed by the appearance of metastases. Once activity is acquired these metastases receive the treatment previously described for active metastases. Exogenous TSH induction consists in giving the patient 100 μg of triiodothyronine/day to prevent all metastatic evolution, this is then stopped and metastases are stimulated by a series of five to nine daily injections of TSH on the last day of which, a tracer ^{131}I dose is given to determine the effect of this type of induction. If the response is positive, 30 to 100 μC of ^{131}I is administered and patients immediately returned to and maintained on triiodothyronine until the next session. There were seven out of ten positive responses using this procedure permitting application of ^{131}I. Finally, metastatic function was induced in seven patients using fractionated doses of ^{131}I (20 μC every 15 days during two to three months). It was successful in five cases, permitting the subsequent adminstration of a therapeutic dose of ^{131}I. This last technique is promising though slow. It is concluded that with the three methods sufficient functional activity was induced in 29 patients out of 80. The possibility exists with the combination subtotal thyroidectomy, triiodothyronine, and exogenous TSH of obtaining a positive result in 59% of cases, and during a 12-yr period of cancer therapy with ^{131}I no untoward side-effects were observed, nor serious anemia nor leukemia attributable to the treatment. (BBB)

13143 X-RAY PELVIMETRY. L. R. Barron, R. O. Hill, and A. M. Linkletter (Lachine General Hospital, Montreal). Can. Med. Assoc. J., 91: 1209-12(Dec. 5, 1964).

X-ray pelvimetry, first described in 1900, has become increasingly popular; however, many obstetricians, especially in North America and Great Britain, differ in their estimation of its value. Some feel that it involves an unnecessary exposure of the mother and unborn baby to radiation and its hazards or that the results are difficult to interpret and misleading. Others think that it offers the solution to most difficulties in the management of pelvic contraction. It is suggested that both of these conclusions are extreme and, while the prognosis for successful labor in any given case cannot be based on x-ray pelvimetry alone, it is a valuable aid in the management of patients with contracted pelvis. X-ray pelvimetry provides more accurate measurements than can be obtained in any other way, and it should be employed in circumstances suggesting the probability of pelvic contraction or potential dystocia. The technic of x-ray pelvimetry varies from hospital to hospital and from courtry to country. The most difficult diameters to measure are the transverse, the transverse of the pelvic inlet, the interspinous, and the intertuberous diameters. The method employed at this hospital involves positioning the patient so that the transverse diameters of the inlet, mid-pelvis, and outlet occupy the same plane. In view of the importance of reducing radiation exposure to the fetus and maternal gonads, an attempt was made to evaluate the usefulness of x-ray pelvimetry in 66 patients. From the results obtained it was apparent that x-ray pelvimetry is a valuable adjunct in the correct management of cases in

which measurements showed evidence of gross bony disproportion. All 17 cases in which the radiologist recorded gross bony disproportion eventually required Cesarean section. Of the 40 cases in which there was no evidence of gross bony disproportion, only two terminated in section. The controversy as to whether or not x-ray pelvimetry in the later weeks of pregnancy is dangerous to the mother and baby is discussed. Theoretically, there is danger to the fetus, both immediate and in its future life in the production of childhood leukemia. There is danger to the gonads of the baby, with a risk of producing an increase in incidence of congenital malformations in later generations. One report shows an increase in leukemia in children of women who underwent radiographic examination during pregnancy, and the risk was found to be present but minimal in Australia. A report from the U.S.A. failed to confirm these observations in a very extensive well-prepared series. It is concluded that the risks to the baby and mother when pelvimetry is performed in the last two or three weeks of pregnancy (when it is usually done) are slight, and the advantages to both mother and baby far exceed any possibility of danger which, up to now, has not been fully or conclusively substantiated. (BBB)

13144 EXPERIENCE WITH THE ^{60}Co IRRADIATION THERAPY ON GASTRIC CANCER PATIENTS. Shojiro Izumi, Tatsuo Takabashi, Naohiko Tokita, and Yoshihiro Sato (Honjo Yuri Kumiai General Hospital, Akita Prefecture, Japan). Can No Rinsho, 9: 396-7(July 1963). (In Japanese)

Because of its low sensitivity to radiation, a large dose of radiation is necessary for eradication of stomach cancer, which often results in contraction of the affected area and obstruction of passage of gut contents in the pylorus region. Of 15 cases of late-stage stomach cancer where operative removal of tumor was not possible, gastroduodenostomy was performed in six cases. There were 12 control cases where spread of cancer to liver or peritoneum or other surrounding organs had taken place, and except in three cases no operation was performed. The operation was performed for the three cases of the control group after irradiation therapy because subsequent pyloric obstruction had occurred. In spite of a successful operation, prognosis of these three cases was not good, and two of them died afterward because of incomplete healing of the anastomosis operation. Three cases were submitted to the operation before irradiation, and their prognosis was satisfactory and no postoperative complications appeared. It is considered that the operation performed before the irradiation permitted the patient to maintain adequate nutritional intake, while it permitted a large dose of radiation afterward, thus effectively prolonging the patient's life. (BBB)

13145 RADIOTHERAPY: MODALITIES AND USES. Cancer Bull., Texas Ed. 16: 6-8(Jan.-Feb. 1964).

The comparative values of Ra and ^{60}Co in the treatment of cancer are discussed. A combination of intracavitary Ra therapy and external irradiation with supervoltage apparatus has proved particularly efficacious in advanced cancer of the uterine cervix. In the early states, external irradiation may be used supplementary to intracavitary therapy with Ra; in later stages it is used first for the whole pelvis and then supplemented with intracavitary Ra therapy. Interstitial Ra implants have also been used, either alone or in combination with external irradiation. In 1962 it was estimated that there were about 50 betatrons, 30 linear accelerators, and at least 1500 to 2000 telecobalt units in operation throughout the world. The most important megavoltage equipment available at this time is that in the 2- to 6-Mev range, which includes x-ray generators, linear accelerators, and ^{60}Co units. The ^{60}Co units are less expensive and bulky, but the output gradually decreases. This energy range is used primarily for head and neck cancer, breast and ovarian cancer, and in lymphoma. The second level, from 15 to 35 Mev, which includes the betatrons or linear accelerators, is used for cancer of the urinary bladder, esophagus, and uterine cervix, as well as for moderately radiosensitive tumors of the torso. Supervoltage radiotherapy is now considered preferable to conventional radiotherapy in squamous cell oropharyngeal tumors (tonsillar region, base of tongue, and pharyngeal walls) though survival rates are only from 10 to 20%. Although the emphasis has recently been placed on supervoltage radiotherapy, there has been an increased interest in other kinds of radiotherapy also. (BBB)

13146 METASTATIC RETINOBLASTOMA TREATED WITH RADIATION AND CONTINUOUS INTRA-ARTERIAL INFUSION OF TRIETHYLENEMELAMINE (NSC-9706). R. L. Lawton, J. C. Taylor, and H. B. Latourette (State Univ. of Iowa and Veterans Administration Hospital, Iowa City). Cancer Chemotherapy Rept., No. 38, 61-2(May 1964).

The successful use of radiation and chemotherapy in a patient with retinoblastoma, which metastasized to the forearm 5 yr after successful treatment of the primary tumor is reported. The forearm lesion was treated with γ and x rays and a total of 8.5 mg of triethylenemelamine (TEM) infused continuously over a 2-week interval. Radiotherapy was begun simultaneously with the local infusion of TEM. A total of 3500 R (measured in the air) was delivered within a period of 22 days to a 20- by 9-cm field over the left forearm with 250-kv x radiation and a Thoraeus filter. An additional dose of 1600 R was delivered to the same area over a 7-day period by using a ^{60}Co teletherapy unit. The distance of the source from the skin was 55 cm. This gave an estimated depth dose in the region of the involved ulna of ~ 4500 to 5000 R. A dose of 0.03 mg/kg/day of TEM was given for 6 days and thereafter at intervals of 2 to 3 days for the 17 days of therapy. Hemoglobin, white blood count, and platelet count, checked daily during the period of treatment, showed no significant changes. The combined therapy was well tolerated locally and systemically. At the completion of treatment there was increased pigmentation of the skin and a decrease in the amount of pain and discomfort in the left forearm. One week after completion of the treatment a slight exudative reaction was noted on the forearm skin, but it healed satisfactorily. One month after therapy had been completed, a radiograph of the distal ulna showed that the contour of the bone was essentially normal and that the periosteal reaction had disappeared. Irradiation may cure retinoblastoma and TEM alone may not, but the two seem to be synergistic or supplementary. (BBB)

13147 ON THE GONAD EXPOSURE IN RADIATION TREATMENT OF ANGIOMAS IN CHILDREN: DOSIMETRIC STUDY DURING RADIATION TREATMENT WITH THE VAN DER PLAAT APPARATUS. V. Bek and V. Michal (Charles Univ., Prague). Cesk. Radiol., 18: 11-19(Jan. 1964). (In Czech.)

By measurements with a water phantom attempts were made to estimate the gonad dose in small children of both sexes treated with the van der Plaat apparatus for contact irradiation. In both sexes it was found that gonad doses changed with the distance of the radiation source from the gonads, size of the irradiated field, different qualities of radiation, direction of the primary beam, and in relation to the nature of the irradiated organ. Even in radiation treatment with soft x rays (50 kv) in the area of the lower half of the trunk and proximal parts of the lower extremities, the gonad doses reached significant or excessive levels even with surface doses that are used in radiation treatment of angiomas with this method. On the other hand, when radiation treatment was directed to areas of the head the gonad dose was negligible. Some implications of radiotherapy of angiomas in children are discussed from the standpoint of genetic effects of radiation. In radiation treatment with soft x rays (Dermopan, van der Plaat and Chaoul apparatus) it is always necessary to consider carefully all factors which determine the degree of gonad exposure from scattered radiation. It is suggested that, at present, it is justified not to use external radiation (radium or other γ irradiators) in the radiation treatment of angiomas in children. Implantation of γ irradiators should be used only exceptionally in angiomas where other therapeutical methods, including surgery, give unsatisfactory results. (BBB)

13148 HEAVY PARTICLES IN NEOPLASTIC, METABOLIC, AND NEUROLOGICAL DISEASE. John H. Lawrence (Univ. of California, Berkely). Clin. Neurosurg., 10: 189-94(1964).

Particles with high energies from large accelerators can be used therapeutically to penetrate deeply into tissues and unload their energy in the form of this dense ionization at the depths, the so-called Bragg curve. Thus, a form of densely ionizing radiation can be delivered to the depths with little skin dose, with little scatter, with a greater biological effect, and it can be accurately placed in the desired area. These particles can be used for the inhibition of pituitary function or the destruction of the gland by externally delivered radiation, the treatment of tumors directly, and the production of lesions in the nervous system for abnormalities such as Parkinson's disease. Since 1955 nearly 300 patients have been treated with heavy particle radiation, including such diseases as metastatic carcinoma of the breast, metastatic carcinoma of the prostate, diabetic retinopathy, acromegaly, and tumors of the brain or soft tissue. In most cases rotation technique for localization of the radiation dose has been used, and in others the Bragg curve. Clinical results are encouraging. In 150 female patients with breast cancer, remissions occurred in about 30%, the periods of remission varying from 6 months to 4½ yr. To slow down diabetic retinopathy, beams of protons or α particles have been used in an attempt to suppress the function of the pituitary gland. Results have been very encouraging; most patients received 8000 to 14,000 rad delivered in 11 days. Following treatment, their insulin requirements showed a marked decrease. Also treated were 20 acromegalic patients, the average dose to the pituitary gland being 4500 rad given in 11 days (range, 3000 to 7200 rad). Nineteen patients are still living; of these, 17 have been relieved of their symptoms. With heavy particles and the Bragg curve, it is also now possible to suppress pituitary function and alleviate the symptoms and signs of Cushing's disease. Two such patients have demonstrated marked changes in their appearance, with disappearance of their Cushingoid features. Treatment of various other diseases with high-energy particles is also described. (BBB)

13149 BONE MINERALIZATION AND DESTRUCTION RATES DETERMINED BY CONTINUOUS FEEDING OF RADIOCALCIUM. B. E. C. Nordin, D. A. Smith, and J. Nisbet (Western Infirmary, Glasgow). Clin. Sci., 27: 111-22(Aug. 1964).

In single-dose radiocalcium procedures to evaluate bone formation, isotopic equilibrium is never established between the exchangeable bone mineral and the extracellular fluid radiocalcium. In the early stages, the sp. act. of the bone is lower than that of the tissue fluid and there is net transfer of isotope by exchange from blood to bone. Later, the specific activity of the plasma falls below that of the exchangeable bone calcium and there is net transfer of isotope from bone to blood. Some of these difficulties were avoided by giving the isotope in frequent small doses over a long period instead of in one dose. Results are reported from 31 studies made on 19 patients (13 cases of osteoporosis, 3 of osteomalacia, and 3 patients with normal bones). They were maintained on a constant diet to which supplements of Ca were added as required. A dose between 0.03 and 0.05 μC $^{45}CaCl_2$ was administered twice daily in 2.5 mg of ^{40}Ca as $^{40}CaCl_2$ together with the morning and evening meals. Urine and feces were analyzed for Ca and assayed for radioactivity. In some cases, blood samples were also obtained for determination of sp act. Plasma specific activity rose for about 10 days and then appeared to reach a stable level, although examination of the urine showed that it probably rose slowly for a little longer. This stable level was generally lower than the sp act. of the diet, but the difference between the two depended upon the stable Ca intake. Bone mineralization rates ranged from 2.7 to 32.0 mg/kg/day, but the two high values were both seen in cases of osteomalacia; most of the remainder were less than 10.0 mg/kg. The mineralization rate was independent of Ca balance. Bone destruction rates ranged from 0 to 34.8 mg/kg/day, the highest values occurring in osteomalacia. Both methods of calculation of destruction rate gave essentially the same result. There was an inverse correlation between Ca balance and bone destruction rate in most cases, but in two cases of osteomalacia the destruction rate was very high relative to the Ca balance. Thus it is shown that if the dose of ^{45}Ca (5 μC) normally given by intravenous injection for the measurement of mineralization rate is given in small divided doses over a period of 50 days, the activity in the body fluids is easily measurable within a few days and reaches a steady level in the blood within 2-3 weeks. It is concluded that the continuous radiocalcium feeding method represents an approach to the problem of bone kinetics which calls for further exploration and opens up promising lines of investigation. (BBB)

13150 COLOR SCINTIGRAPHY. H. Oeser, H. Ernst, and K. Rach (Universitat, Berlin). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 101: 640-4(Dec. 1964). (In German)

Differential concentrations of radioactivity could be distinguished more readily by a color scintigram than by other methods of recording. This was proved by experiments with phantoms and with two examples in the diagnosis of thyroid disease using radioiodine. (auth)

13151 RESULTS WITH COLOR SCINTIGRAPHY. R. Wolf and J. Fischer (Universitat, Mainz). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 101: 644-52(Dec. 1964). (In German)

Reasons why color scintigrams are preferred to the black and white scintigrams are discussed. They provide better contrast without the danger of any loss of information. To achieve similar results with photoscintigrams requires more time and more complex apparatus. The color scintigrams provide the necessary contrast immediately. (auth)

13152 THE COMPARATIVE INVESTIGATION OF IRON AND ALUMINUM FILTERS IN X-RAY DIAGNOSTICS. G. Koczkas, I. Bojtor, and E. Sarmai. Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 101: 661-4(Dec. 1964). (In German)

One of the main sources of radiation to the general population is considered. A reduction in the radiation dose provided by diagnostic radiology is discussed. The radiation dose using iron and aluminum filters was compared. Measurements indicated that the use of iron filters results in a dose reduction of several percent. (auth)

13153 PROTECTION NORMS AGAINST IONIZING RADIATION IN THE HOSPITAL CARE OF PATIENTS INTO WHOM NONSEALED RADIONUCLIDES HAVE BEEN INTRODUCED. Vittorio Perotti and Giuseppe Pompili (Ospedale Maggiore, Milan). Igiene Mod. (Parma), 55: 657-71(Sept.-Oct. 1962p. (In Italian)

Patients who for diagnostic purposes bear implanted radionuclides can be treated normally, but if vomiting occurs in the first 24 hr, radiation protection measures must be taken. Urine, feces, and sputum collected for tests should be handled with utmost care, and dirty laundry should be handled with gloves. Hospital personnel should spend a minimum time with the patient, washing carefully after touching him, collecting any suspected or known contaminated materials, taking radiation precautions if patient faints, and postponing baths for 48 hr after implantation. All personnel in contact with patients having been administered above 30 mC or ^{131}I and ^{198}Au should wear dosimetric film badges. Other patients at a distance of two m from a patient treated with ^{198}Au colloidal suspension (1 mC) will absorb about 0.5 rad (0.6 mR/hr) in the first week. For each 10 min. spent adjusting the bed or bathing the patient, about 0.17 mR for each mC of ^{198}Au will be absorbed by personnel over the entire body if in the patient's room for 8 hr. The dosage for hands only is about 1.7 mR for each mC of ^{198}Au for each 10 min during adjusting the bed and bathing. These values are reduced by 25% each 24 hr. The absorption dose for six days over the

entire body is 175 to 200 mRad, and 1.75 to 2 rad for hands only during this period. The usual administered quantities of ^{131}I and ^{198}Au are about 1 to 15 mC in hyperthyroidism, 5 to 25 mC in cardiopathy, and 20 to 200 mC in neoplastic thyroid disease. Hospitalization is only necessary at quantities above 30 mC. In the first 48 hr all bedding should be covered with plastic sheets because ^{131}I not only can be eliminated by the urinary tract but also through perspiration. The maximum admissible time exposure in patients having been administered ^{198}Au or ^{131}I at distances of 50 cm, 1 m, 1.5 m, and 2 m are: for 25-mC doses, 2, 8, 18, and 24 hr; 50-mC doses, 1, 4, 9, and 16 hr; 100 mC doses, 0.5, 2, 4½, and 8 hr; for 150 mC, 0.3, 1.5, 3¼, and 6 hr; and 200-mC doses, 0.25, 1, 2¼, and 4 hr. Colloidal ^{32}P represents no risk unless the material is lost through a wound, in which case norms established for ^{198}Au should be used. With regard to soluble ^{32}P administered intravenously and orally, vomiting can occur in the first 24 hr at dosage above 3 mC; therefore, rubber gloves and the usual radiation precautions for such excreted materials should be used. (BBB)

13154 SPECTRA OF THE INTERNALLY SCATTERED RADIATION FROM LARGE Co^{60} SOURCES USED IN TELETHERAPY. J. H. Aitken and W. H. Henry (National Research Council, Ottawa). Intern. J. Appl. Radiation Isotopes, 15: 713-24(Dec. 1964).

Because of internal scattering and degradation of the 1.33 and 1.17 Mev quanta, the beam of radiation from a ^{60}Co teletherapy unit includes a continuous spectrum extending well below 1 Mev. The form of this spectrum below 1 Mev and its intensity relative to the radiation above 1 Mev were investigated for sources of various dimensions. The influence of the material around the source, the relative spectral contributions of different parts of the source, and the spectra from bare sources outside the teletherapy head were also studied. Methods of designing source and head to minimize the radiation below 1 Mev may be inferred from the graphs. (auth)

13155 EFFECT OF ALTERING PHYSICAL ROENTGENOGRAPHIC FACTORS ON PATIENT RADIATION DOSE LEVELS. P. E. O'Shaughnessy and D. F. Mitchell (Indiana Univ., Indianapolis). J. Am. Dental Assoc., 69: 335-42 (Sept. 1964).

The relative amounts of primary and secondary radiation received by tissues in relation to changes in the roentgenographic equipment and technics were investigated. Measurements were made by implanting small dosimeters in selected sites in a cadaver to determine which combinations of advocated technics are the safest, in light of present knowledge of radiobiologic damage. If any one combination of physical factors routinely delivered a minimal dose to any particular region, it was assumed that this technic was safer than the other possible technics and, as such, was advocated for use by the dental profession. To determine which of eight combinations of three physical safety factors of the x-ray machine was the safest to use during routine intraoral roentgenography, three variables were studied: target-film distance, filtration, and collimation. All eight combinations were used at 70, 80-, and 90-kvp levels (24 combinations). Each combination was used to measure the ionization radiation level at seven body areas, during a routine, full-mouth intraoral roentgenographic survey: pituitary, thyroid, porta hepatis, hilus of the spleen, adrenal gland, testes, and femur. No single combination of physical safety factors measured was found to be the safest (lowest dose received) for all seven sites measured. Collimation of the beam appeared to be the most important single factor in reducing unnecessary primary, secondary, and scattered ionizing radiation. All radiation doses received were small, and it was concluded that the dentist can use roentgenography for diagnosis with safety. (TCO)

13156 EFFECT OF CANCER TREATMENT ON SKIN HOMOGRAFT SURVIVAL. John B. Graham and Natalija Petersons (Roswell Park Memorial Inst., Buffalo). J. Am. Med. Assoc., 189: 697-8(Aug. 31, 1964).

The effect of radiotherapy and surgery on graft survival was studied in 198 patients with cervical cancer. A full-thickness ellipse of skin, 0.6 × 1.0 cm, from another patient was applied to the forearm before therapy. The first sign of blanching or cyanosis was regarded as the end of survival, and grafts that survived 15 days or more were classified as prolonged. In the patients who received no cancer treatment the magnitude of the cancer lesion did not appear to influence the rejection time. Only 7% of the grafts survived more than two weeks. Hysterectomy was done on 36 patients while the graft was present; in ten (28%) the graft survived more than two weeks. Radiotherapy was begun for 46 patients during the graft, usually as x rays directed toward the entire pelvis giving about 1000 R per week in the region of the cervix. A few patients were treated with radium. The grafts survived more than two weeks in 22 (48%) of the irradiated patients. These data suggest that major surgery performed on a patient after a homograft was applied prolonged the graft survival and that radiotherapy given in the same sequence apparently had an even greater effect. The most constant effect was noted in the nine patients given radiotherapy before and during the graft; two-thirds showed prolonged survival. The percentage of grafts surviving more than two weeks was almost the same for both those patients starting radiotherapy in the first week after grafting and those starting in the second, 12 of 27 (45%) and 7 of 16 (44%), respectively. The manner in which these treatments influenced homograft survival was not established. Stress, with its increased corticoid secretion, and the effects of radiation on immunity mechanisms are probably the factors involved. (BBB)

13157 LUNG CORRECTIONS IN COBALT-60 BEAM THERAPY. H. F. Batho (British Columbia Cancer Inst., Vancouver, Can.). J. Can. Assoc. Radiologist, 15: 79-83 (June 1964).

The problem of correcting dose estimates for the effects of lung tissue in the radiation field is discussed. Possible solutions are considered. The usual method of correcting for lung tissue is to estimate the doses at the required points without regard for lung, and then to multiply all doses by a common factor. Where the dose is being determined at several points in the radiation field to determine the dose distribution accurately, the lung correction should be made for each point separately. Two methods of making point-by-point corrections are discussed, and data presented for ^{60}Co γ radiation, the methods being applicable with any supervoltage radiation. An approximate method of correcting the dose at each point was deduced by extension of a method used to correct for oblique incidence. It is shown that, with ^{60}Co radiation, for a medium-size field (about 100 cm^2) each centimeter of air gap between treatment applicator and skin increases the dose about 5.4 or 5.5%, provided the point at which the dose is being estimated is several centimeters below the skin. Assuming lung tissue has an average density of 0.35 g/cm^3, each centimeter of lung is equivalent to an air space of 0.65 cm and should increase the dose by 0.65 × 5.4% = 3.5%. The correction method based on tissue-air ratios is also discussed, and a comparison was made of the two methods for a typical case. It was established that the estimated distribution of dose in the treatment volume depends significantly on the lung correction. A comparison of the two methods of correction showed that the 3.5% per cm rule results in a larger correction at all points, but the difference in the average dose estimated by the two methods is scarcely significant. It is apparent that errors in estimating the volume of lung in the field will make more difference than the choice of method of correction. However, the dose distribution can be determined somewhat more accurately by means of the table that is included. (TCO)

13158 THE ACUTE RADIATION PNEUMONITIS SYNDROME. John A. G. Holt (Inst. of Radiotherapy, Western Australia). J. Coll. Radiologists Australasia, 8: 40-7 (Feb. 1964).

Late radiation-induced fibrosis of the lung is a well-recognized entity which appears at least five or six months

following the course of irradiation and which continues slowly to progress, usually reaching some finality at about 18 months. Clinical results are reviewed for 102 patients given radical megavoltage therapy for inoperable carcinoma of the bronchus. Routine monthly radiographs revealed that 15 had acute lung reactions which appeared earlier than 12 weeks after cessation of treatment. Seven cases appeared under five weeks post-therapy; of these two died at four weeks, four died at eight weeks, and one died at 12 weeks, all from acute pneumonitis. Of four with mild reactions, all completely resolved radiologically, three died after six months of the disease and one survived without obvious tumor or reaction at 14 months. An analysis of the methods used and total tumor doses delivered shows that many of these patients received 6000 rad in six weeks to moderate size volumes about the hilum and mediastinum with no early detrimental effect. However, there was generally a correlation between the severity of the reaction and the dose rate. At more than 1000 rad tumor dose of 4 Mev x rays per week (corrected for lung aeration) delivered by three or four fields to a volume of 800 ml or more, acute radiation pneumonitis was fairly common and became of little importance when this dose rate was reduced to 700 rad per week. Once the reaction has commenced, to continue irradiation is to increase its speed of progress and will lead rapidly to death. This relation to the dose rate does not hold the same relation that exists between radiation and late lung fibrosis. Here total dose delivered is more important, the incidence of fibrosis and its severity being roughly proportional to the total delivered dose. This probably explains why the syndrome has not been described clearly before. (BBB)

13159 SYMPOSIUM ON THYROID DISEASE. I. THYROID SCANNING AND THE PROBLEM OF THE SOLITARY NODULE. J. K. Donovan (Royal Prince Alfred Hospital, Sydney). J. Coll. Radiologists Australasia, 8: 94-8(June 1964).

In addition to the total uptake of radioiodine by the thyroid, it is possible to obtain further information about the gland by examining the relative distribution of ^{131}I throughout its substance. With an automatic scintiscanner a finely collimated probe tracks backwards and forwards across the neck, with each track separated by an interval of about 2 mm from the next, and the activity detected as it traverses across the thyroid is continuously recorded by dots on prepared paper, or by dots on a photographic film produced by a light source whose brightness is made to vary with the counting rate. This provides an outline of the functioning area of the thyroid and also detects areas where increased or decreased amounts of ^{131}I have been concentrated. However, if all portions of the thyroid are concentrating radioiodine equally well, an area that is thicker than the rest will show a slightly increased concentration of radiation on the scintillation scan. The scans obtained using a Picker Magnascanner with a 31-hole fine focus collimator are illustrated as exemplifying various types of thyroid disorders. The ^{131}I uptake of a thyroid nodule cannot be measured absolutely, but can be conveniently compared with two standards: the level of ^{131}I uptake in the rest of the thyroid, and the vascular background of ^{131}I in the neck. (TCO)

13160 SYMPOSIUM ON THYROID DISEASE. 2. DIAGNOSIS AND NON-OPERATIVE TREATMENT OF THYROTOXICOSIS. J. Coll. Radiologists Australasia, 8: 98-103 (June 1964).

After a discussion of the use of radioiodine in diagnosis, its application to the treatment of thyrotoxicosis is considered, along with possible complications. Radioiodine therapy depends on the local irradiation of thyroid cells by the β emanations of the accumulated isotope; consequently complete or partial destruction of cells occurs, reducing the amount of thyroid hormone secreted into the circulation. Results of radioiodine therapy throughout the world show about 98% permanent relief of thyrotoxicosis. The relief of symptoms is relatively slow, and rarely is apparent under six weeks and often considerably longer. A repeat dose of radioiodine is generally contraindicated earlier than 10 weeks after the initial dose. Most patients develop a minor initial degree of radiation thyroiditis about one week after therapy, but usually this is of no inconvenience to the patient. However, in the very thyrotoxic patient the condition may be exacerbated and the patient may develop thyroid crisis after radioiodine therapy. Cardiac failure may also result from this exacerbation of the disease. Although the initial hypothyroid rate is often low, the problem of late development of hypothyroidism is serious. The risk of cancer resulting from radioiodine therapy is negligible except in children and adolescents; the risk of leukemia appears to be nonexistent providing the dose is kept in the low range (e.g. less than 20 mC). The genetic effect cannot be assessed, but radioiodine should not be used during pregnancy or lactation. (TCO)

13161 DIGITAL COMPUTER ANALYSIS AND DISPLAY OF THE RADIOISOTOPE SCAN. Donald W. Brown (Univ. of Colorado, Denver). J. Nucl. Med., 5: 802-6(Oct. 1964).

A method of approaching the analysis of the radioisotope scan objectively using statistical testing with a digital computer is under development. Pulses from the pulse height analyzer of the scanner are summated at one second intervals and fed into a computer. By this means, variation in activity from adjacent areas can be evaluated for statistical significance. The computer's printer can then be used to print out scans graphically, allowing one to vary the background erase and contrast enhancement. Lesions can sometimes be clearly demonstrated by this technique when they can only be suspected on ordinary scans. (auth)

13162 Tc^{99m} PERTECHNETATE FOR BRAIN SCANNING. J. G. McAfee, C. F. Fueger, H. S. Stern, H. N. Wagner, Jr., and T. Migita (Johns Hopkins Univ., Baltimore). J. Nucl. Med., 5: 811-27(Nov. 1964).

In a series of 133 patients with suspected brain tumors ^{99m}Tc-pertechnetate produced significantly better brain scans than were obtained using ^{131}I-albumin or ^{203}Hg-chlormerodrin. Although clinical experience with this agent is still limited, it would appear that certain tumors frequently missed with older agents, such as low grade astrocytomas and suprasellar cysts, may be missed also with pertechnetate. The concentrations of this material in transplantable gliomas and normal brain tissues of mice were similar in magnitude to those obtained with the older agents. The superiority of the labeled pertechnetate appeared to be due entirely to its physical characteristics, i.e., essentially monoenergetic gamma emissions of 140 kev, absence of beta emission, and short physical half-life of six hours. These characteristics permitted the administration of relatively large doses of 10 mc and a significant reduction in the procedure time; yet the radiation doses were kept below the levels obtained with other agents. The radioactive preparation is easily obtained on a daily basis from a commercially available ^{99}Mo-^{99m}Tc generator. The intravenous mode of administration was preferred over the oral, although both methods of administration were tried. (auth)

13163 THE LOCALIZATION OF RADIOANTIBODIES IN HUMAN BRAIN TUMORS. III. RADIOIODINATION OF PREPURIFIED LOCALIZING ANTIBODY. Eugene D. Day, Sylvester Lassiter, and M. Stephen Mahaley, Jr. (Duke Univ., Durham, N. C.). J. Nucl. Med., 6: 38-52(Jan. 1965).

Experiments are described that demonstrate the problem of the presence of contaminating protein in antibody eluates. It is shown how a partial separation of pre-purified antibody from such proteins can be obtained so that subsequent radioiodination results in as much as a fifty-fold increase in specific labeling of antibody over that of whole antiserum globulin. Columns of DEAE-A50-Sephadex were used to separate eluted antibody from eluted tissue protein. The rat kidney-antikidney and rat spleen-antispleen systems serve as models for the experiments and finally the human glioma-antiglioma system was also tested. (P.C.H.)

13164 CONTRIBUTION TO THE STUDY OF THE DOSIMETRY IN FIXED-FIELD TELECOBALT THERAPY.

G. Giaux, J. Swyngedauw, J. Rohart, and R. Rozan. J. Radiol. Electrol. Med. Nucl., 45: 547-60(Oct. 1964). (In French)

A method of γ dosimetry is proposed that makes it possible to develop in advance and in a definitive fashion combinations of isodoses that are independent, to a large measure, of the dimensions and morphology of the body irradiated. The necessity for dose calculations for each individual case is reduced, making it possible to develop a precise study of the irradiation plane in a minimum of time. For the study and elaboration of the isodoses, expressed in percentages of the dose at the tumoral axis, two cases were assumed, one that the irradiated body is homogeneous and the other that the body is non-homogeneous. Some practical examples of the utilization of the isodose curves and their combinations are given. (J.S.R.)

13165 AN EXPERIMENTAL STUDY OF SIMULTANEOUS IRRADIATION AND REGIONAL CHEMOTHERAPEUTIC PERFUSION. Paul Clapp, Manuel S. Tayao, Ella B. Tyree, James J. Nickson, Rayard Clarkson, and Walter Lawrence, Jr. (Sloan-Kettering Inst. for Cancer Research, New York). J. Surg. Res., 4: 371-6(Aug. 1964).

Observations were made on the effect on an animal tumor of the combination of regional chemotherapeutic perfusion using various carcinostatic agents and simultaneous external radiotherapy. The VX2 carcinoma transplanted in the hind limb of rabbits was found to be a satisfactory experimental preparation for carrying out such regional perfusion and radiation studies. The response of this tumor to regional perfusion with various agents and to graded single doses of medium voltage x rays (250 kv) was evaluated. At maximum tolerated dose combinations, the combined treatment produced no significant increased tumor suppression as compared with the response to irradiation alone at the same dose 2000 R in the control limb, and did not improve the therapeutic index. At lower irradiation doses (1000 R), a partial additive effect of the combined treatment using actinomycin D was apparent, but toxicity was comparably increased. With none of the drugs tested (nitrogen mustard, cyclophosphamide, mitomycin C, and actinomycin D) was a more favorable therapeutic response obtained than could be achieved with optimal doses of irradiation or drug perfusion alone. It was concluded that combining chemotherapeutic perfusion of any of these agents with simultaneous irradiation does not produce additional therapeutic benefit over irradiation or drug perfusion alone in this experimental tumor system. It is suggested that sequential, rather than simultaneous, combination of these two modalities might achieve better results. (TCO)

13166 TWO CASES OF SEVERE RADIATION BURN: MALIGNANT MELANOMA OF THE EXTERNAL AUDITORY CANAL AND LARYNGEAL CANCER. Teruko Oda and Yoshiko Nakanishi. Jibi Inko-ka, 36: 201-5(Mar. 1964). (In Japanese)

A macroscopic and histologic study was made of two patients who developed severe dermatitis and ulceration as a result of high-dosage radiation treatment for malignant tumors in the head region. The skin changes are extensively illustrated by photographs and micrographs. The first case was that of a woman, aged 57, whose right external ear canal affected with malignant melanoma was treated by irradiation using 4400 R of x ray, 6100 R of ^{60}Co γ radiation, and implantation of 9 radon seeds. The second case was a man, aged 65, affected by laryngeal cancer. He was treated by γ irradiation with 6100 R from ^{60}Co; when metastasis of the cancer occurred on the right neck, this area was given another exposure of 6100 R of ^{60}Co γ radiation. In the first case the burn occurred in the region of the ear and in the second in that of the neck. Both cases proved to be highly resistant to treatment, nonhealing ulcers developing in the heavily irradiated skin. Tolerance of the skin to various radiation doses and the histopathology of radiation-induced skin lesions are discussed. (BBB)

13167 CHRONIC BRONCHITIS AND RADIOTHERAPY OF THE LUNG. P. M. S. Gillam, P. J. D. Heaf, B. I. Hoffbrand, and Gwen Hilton (University Coll., Hospital, London). Lancet, 1: 1245-8(June 6, 1964).

Attempts were made to evaluate the effects of irradiation, for lung cancer, on pre-existing bronchitis. The 161 patients studied were divided on their history alone into three main groups. Most patients were irradiated with 3000 to 3500 R by conventional 250- or 300-kv units, but a few received treatment with the telecobalt unit. There was no significant difference between any of the groups in the average dose, or in the average dose per treatment, or in the length of the course of treatment. There was no evidence that patients with mild bronchitis survived longer than those with more severe bronchitis. The nonbronchitics, on the contrary, did less well than the other groups; this became statistically significant when contrasted with the survival of the bronchitics after thirty weeks, but cancer was further advanced in the nonbronchitic group. Evaluation of the frequency of complications in the various groups showed that fever, without evidence of bronchitis, occurred with equal frequency in all. The prevalence of radiation pneumonitis and fibrosis in the three groups was the same in all the groups. The mean tumor dose received by patients in whom pneumonitis developed was greater in all groups. Radioinduced changes were more frequent in the patients treated on the cobalt unit, and this difference was highly significant. These results show that patients with chronic bronchitis are no more difficult to treat than those without, nor does radiotherapy worsen the bronchitis during or after treatment. Patients with severe chronic bronchitis survive as long as those with mild bronchitis: nonbronchitics could not be compared with bronchitics because their growths were more extensive. (TCO)

13168 ALKYLATING AGENTS, ANTI-METABOLITES, ALKALOIDS AND X-RAYS IN THE TREATMENT OF INOPERABLE BRONCHOGENIC CARCINOMA. M. Aronovitch, J. Bouchard, L. Kahana, M. Groszman, J. F. Meakins, J. Hazel, and A. Jalil (Queen Mary Veterans Hospital, Montreal). Med. Serv. J. (Can.), 20: 471-82(May 1964).

A study was undertaken to evaluate the effects of combined methods of non-surgical therapy, particularly certain combinations of radiation and chemotherapy, in inoperable bronchogenic carcinoma. The usual course of chemotherapy started with 200 mg of cyclophosphamide intravenously for two or three days, followed by 100 mg intravenously or orally daily as tolerated by the patient. At the same time, 5-fluorouracil (5-FU) in doses of 500 mg intravenously was given daily for six days. Radiotherapy consisted of both deep x rays and ^{60}Co in doses that varied from 5000 Rad over a 45-day period to lesser amounts over shorter periods. Chemotherapy alone had no influence on the survival time of patients with bronchogenic carcinoma. A significantly increased survival was, on the other hand, evident in the group treated with radiation combined with chemotherapy, the average survival time being 10.4 months, which is higher than the average of 8.2 months for radiotherapy alone and considerably higher than that for chemotherapy alone (2.9 months). Of the patients receiving simultaneous 5-FU and x-ray therapy as described, the number showing x-ray improvement was high (85.7%) but the survival time did not improve and these patients died in the average time of 5.6 months. The survival time was chiefly influenced by the dose of radiation; the higher the dose the longer the survival. On the other hand, radiotherapy simultaneously with chemotherapy produced a higher incidence (85%) of x-ray regressions than when radiotherapy preceded or followed chemotherapy. This may indicate a synergistic effect of radiation and chemotherapy on the neoplastic cell itself, assuming that these act on different aspects of the cell metabolism. Another explanation is the possibility of increased vascularity in the region of the tumor, resulting from radiation therapy, so that the tumor is more penetrable by the agent used. It was concluded that the best results in survival time are obtained when x-ray therapy precedes chemotherapy. (BBB)

13169 WHAT CAN BE EXPECTED FROM TREATMENT WITH NATURALLY OCCURRING RADIOACTIVE

WATERS. G. A. Schoger (Versorgungskuranstalt, Bad Munster, Ger.). Med. Welt, 34: 1771-5(Aug. 25, 1962). (In German)

The curative effects of radioactive waters is related to the radiation emitted. According to present knowledge much of their effect is exerted on the endocrine glands, such as the adrenal medulla and cortex, thyroid, and hypophysis. The blood-forming organs are also affected, as shown by changes in the blood picture. One effect of treatment with radioactive water, the reduction of neuralgic and neuritic pain, may be related to the lipotropic properties of Rn. Effects of radioactive waters on rheumatic diseases such as rheumatoid arthritis, arthrosis, spondylitis ankylopoetica, spondylosis, spondylarthrosis, myalgia, or myosistis may be mediated by way of the endocrine pathways. Contraindications for treatment with radioactive waters include all febrile diseases, malignant growths, active or suspected tuberculosis, coronary sclerosis, infarcts, cardiac insufficiency, infected foci, pregnancy, mental disease, and latent tetany. Generally, reports indicate that 70 to 80% of instances of rheumatic or arthritic conditions show improvement after treatment at mineral springs where radioactive waters are available. (BBB)

13170 THERAPEUTIC SYNERGISM AS THE PROBABLE EXPLANATION FOR THE COMBINED EFFECT OF X RAY AND MYLERAN IN CHRONIC MYELOSES. V. Svoboda (County Hospital, Usti n. Labem, Czechoslovakia). Neoplasma, 11: 95-101(1964). (In German)

Past studies have shown that combined treatment of chronic myeloses with x ray and Myleran, 1,4-bis(methylsulfonyloxy)-n-butane, has several advantages. The total dose of x ray directed to the spleen required for positive results is from 600 to 2000 R, given over a period of up to two months. In order to obtain similar results with Myleran it is necessary to give between 200 to 500 mg over 4 to 16 weeks. Experience shows that the effectiveness of both of these treatments decreases with repeated treatment, but combined treatment with both is more consistently effective. Clinical experience also shows that it is unnecessary to use the same or as high a dose of either treatment when both are given in order to obtain results equally as good. In a series of 43 treatments that included 18 patients, satisfactory remissions were obtained with the use of an average of 114.7 mg Myleran and 641 R of x rays to the spleen, over a period of 30 days. The remissions lasted an average of 5.5 months. The effects of 100 mg of Myleran was about equivalent to that of an x-ray dose of 400 R. When the combined treatment consisted of 1150 R of spleen irradiation and 110 mg of Myleran, the remission obtained was no better, indicating that overdosing with radiation had no advantages. The interval between radiation treatment was important. When 60 R was given daily, it was excessive, but 70 R per week was insufficient. Therapy became protracted, and the daily dose of Myleran had to be increased to 4 mg. The therapeutic optimum was a thrice weekly irradiation of the spleen with 60 R, and daily administration of 4 mg of Myleran. No resistance to this combined treatment was observed. (TCO)

13171 STUDIES OF RENOSCINTIGRAM. SECOND REPORT. METABOLISM OF ^{203}Hg NEOHYDRIN. Goichi Momose, Shin-ichi Mitsuhashi, Takao Ishikawa, and Narimoto Nin (Chiba Univ., Japan). Nippon Hinyokika Gakkai Zasshi, 54: 1026-33(Oct. 1963). (In Japanese)

Studies on the metabolism of Neohydrin were conducted in humans after the intravenous injection of 100 μC of ^{203}Hg-Neohydrin. Patients with normal renal function were used. Scintography in this method with ^{203}Hg-Neohydrin should be carried out within 1 to 4 hr after its administration. The concentration of ^{203}Hg, injected into the blood vessel, decreased exponentially to become very low 48 hr after the injection. Most of the excretion is completed already within 24 hr after injection, the total amounting to about 70 to 80% in the urine within 5 days, while within 8 hr 50% was eliminated. In spite of the increase of the urinary excretion the concentration in the blood went up to 3 to 4 hr after the injection to reach a maximum. The renal deposition of ^{203}Hg-Neohydrin was of such duration as to expose the pelvic mucosa to about 14.4 rad, provided 100 μC was given. (BBB)

13172 DOSE DISTRIBUTION OF RADIATION THERAPY. PART I. ON THE TUMOR VOLUME DOSE RATIO. Tadashi Miyakawa and Yuh Ihno (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 21: 719-32(Oct. 25, 1961). (In Japanese)

Tumor volume dose ratio (R) is defined as follows: R = (Volume dose of tumor)/(Volume dose of whole-body). The tumor volume dose ratios for surface irradiation, contact irradiation, and interstitial implantation are discussed. Volume dose of whole-body for surface irradiation and contact irradiation was considered for the use of radium. It was assumed that the human body is a cylinder. The volume dose of whole-body with radium placed on the midpoint of the axis of this cylinder was computed as the percentage of volume dose of an infinite absorber. As the absorption coefficient hardly changes for γ rays in the energy range of Ra, the values that are given can be employed for other radioisotopes. Contact irradiation is used for very thin superficial lesions, but it is difficult to apply the concept of volume dose in this case, and thus computation is difficult. R values were calculated for ^{131}I treatment of thyroid cancer and the ^{32}P treatment of hematopoietic tissues for leukemia. From the standpoint of measurement of R, moving field irradiation is similar or inferior to fixed irradiation, but dose distribution in the lesion is far superior. With interstitial implantation it is desirable to use β emitters, but further study and development are necessary to improve the existing treatment procedure for injection of radiocolloids into tissue. In studying the space dose distribution by various radiological procedures, three factors should be considered: percentage depth dose (P), tumor volume dose ratio (R), and tumor dose distribution homogeneity ratio (α). (TCO)

13173 A COMPARISON OF COMPLICATIONS SEEN IN COBALT-60 AND CONVENTIONAL ROENTGEN TREATMENT. Hideo Irie, Teruhiko Takita, Keiichiro Onizuka, and Teruzo Yasuda (Kyushu Univ., Fukyoka). Nippon Igaku Hoshasen Gakkai Zasshi, 21: 1163-9(Mar. 25, 1962). (In Japanese)

Of 161 patients with malignancies, 76 were treated with conventional x rays and 85 with ^{60}Co. The percentages of those unable to complete the course of therapy and the reasons for cessation of irradiation were determined. After x-ray treatment 71 cases (93.4%) were unable to complete treatment; 5 cases (6.6%) completed treatment receiving a 4000 rad tumor dose. In more than half of 76 patients treated with conventional x rays the injury to the skin was responsible for stopping treatment; 45 cases could not complete therapy for this reason (59%). This was followed by decreased white blood cell count (19 cases, 25%) and general prostration (7 cases, 9.2%). After ^{60}Co treatment 25 cases (29.5%) were unable to complete treatment because of complications; 60 cases (70.5%) successfully completed treatment, receiving a 4000 rad tumor dose. Cobalt-60 treatment was discontinued because of general prostration in 11 cases (12.9%), decrease of white cell count in 9 cases (10.5%), and skin injury in 5 cases (6%). (BBB)

13174 CLINICAL OBSERVATIONS ON RECTAL DISORDERS CAUSED BY RADIOTHERAPY OF CERVICAL CANCER. Shiro Miyauchi (Nagasaki Univ., Japan). Nippon Sanka Fujinka Gakkai Zasshi, 15: 1019-28(Sept. 1963). (In Japanese)

A total of 631 cervical cancer patients treated from 1948 through 1961 were studied for rectal disorders caused by radiation therapy. Of the 631 patients, 284 cases were in advanced stage. The clinical observations included subjective and objective symptoms, rectoscopic, histologic, and radiographic examinations, and a number of causal factors. The radiation therapy used consisted of fixed x irradiation at 4500 to 12,000 R doses, ^{60}Co pendulum irradiation at

10,000 R doses, close-range irradiation of Ra or ^{60}Co, or combinations of these. It was shown that the early stage rectal radiation injury was manifested by diarrhea and rectal bleeding. These symptoms were found among 39% of those who received x irradiation; 53.5% of those submitted to operation plus Ra, or ^{60}Co plus x irradiation; 52.7% of those who received Ra or ^{60}Co irradiation; and 72% of those who submitted to operation plus Ra or ^{60}Co irradiation. It was also shown that in the late stage of rectal injury exhibiting the primary symptom of rectal bleeding few cases were found among the x-irradiation group, 28.1% of the operation-plus-Ra or ^{60}Co-plus-x-irradiation group; 68.3% of the Ra- or ^{60}Co-irradiation group; 52.9% of the operation-plus-Ra-or ^{60}Co-irradiation group. Rectoscopic examination of 63 cases in the early stage and 122 cases of late stage rectal injury revealed only two cases of ulceration in the early stage compared with 14 cases of ulceration, 6 cases of rectal constriction, 5 cases of anal constriction, and 13 cases of abnormal bleeding in the upper rectum in the late stage. Examination of a number of causal factors showed that cases of the radio-induced rectal disorders were more numerous among patients in senility, with obesity, in advanced stages of cancer, in nulliparous women, in those with anteriorly positioned uteri, and with hemoglobin levels above 70%. (BBB)

13175 INTRAPELVIC DISTRIBUTION OF RADIATION DOSES USED IN RADIOTHERAPY FOR CURE OF CERVICAL CANCER AND RESULTANT RECTAL DISORDERS. Shiro Miyauchi (Nagasaki Univ., Japan). Nippon Sanka Fujinka Gakkai Zasshi, 15: 1137-42(Oct. 1963). (In Japanese)

Increasing attention has been given to bladder and rectal disorders caused by radiotherapy for cure of cervical cancer. In an attempt to prevent the excessive doses causing these complications, the intrapelvic distribution of radiation doses given by fixed x irradiation, ^{60}Co pendulum irradiation, and Ra implantation were measured. Results are reported using a life-size phantom of the human pelvis, a colonial Universal Dosemeter, and a Siemans Gamma-Meter. Treatment of the rectal disorders caused by radiotherapy was attempted on 81 early cases and 26 more advanced cases. It was observed that generally the former group responded favorably and recovered quickly as a result of temporarily halting irradiation and administration of palliative enemas, except in 45.7% of the cases which did not improve. It was also observed that no satisfactory therapy is available for the advanced rectal disorders with stubborn rectal bleeding due to ulceration and necrosis. In addition to the palliative therapy administered to the early cases, hydrocortisone was used for the advanced cases, but without satisfactory results. An operation providing for a plastic surgical reconstruction of the anus was performed on four cases of rectal constriction and anal ulcer, but no long-term improvement was possible because of recurring cancer. It was concluded that since no satisfactory therapy is available today for cure of advanced rectal disorders, vigorous use of dosimeters should be made to prevent or lessen the radiation hazard to the rectum. (BBB)

13176 EXPERIMENTAL EVALUATION OF RADIOACTIVE NUCLIDES FOR ISOTOPIC RADIOGRAPHY. Harry D. Spangenberg, Jr., and M. L. Pool (Ohio State Univ., Columbus). Oral Surg. Oral Med. Oral Pathol., 16: 159-69 (Feb. 1963).

Forty-eight radionuclides were experimentally examined for their usefulness in isotopic radiography of the hard structures of the body. The criterion for evaluation was based upon a combination of the availability of the radioisotope, ease of its production, its half life, suitability of the emission spectrum, and specific activity of the sample in which the isotope is contained. A table is provided listing, for each isotope, the energies of useful and detrimental radiations, percentage of the detrimental spectrum, half life, method of production (parent nuclide and bombarding particle), percentage enrichment of parent isotope, cost per mg, and neutron cross-section. New or modified energy-level diagrams for 20 radionuclides were determined. Nuclides with half lives of a few hundred days are more practical than those with very short or very long half lives. The foregoing considerations are best met by the radionuclides ^{144}Ce, (half life 290 days), ^{153}Gd (236 days), ^{159}Dy (134 days), ^{170}Tm (127 days), and ^{181}W (140 days). The experimental procedures used showed the feasibility of the substitution of 11 radionuclides for conventional x-ray machines in the production of radiograms or roentgenograms. Radionuclides with proper characteristics can be fabricated into a very small portable source. (TCO)

13177 TECHNIC OF REDUCING DOSE IN STEREOSCOPIC CHEST FILMING. Paul C. Hodges (Univ. of Chicago). Postgrad. Med., 35: A91-6(Jan. 1964).

When x-ray films are made, the patient's body should be spared any radiation not essential to the examination, but in practice it is difficult to achieve such tissue sparing unless protective devices are built in. Of all such devices, the most important is a rectangular collimator which restricts the x-ray beam precisely to the area required for the particular film and target-film distance being employed. However, in making stereoscopic chest films with a commercial tube stand and cassette changer, in addition to the useful radiation, an unneeded 6-in. band of exposure to the head and neck for the upper position of the tube and to the abdomen for the lower position results. A stereoscopic tube stand is described, which overcomes overlapping of the x-ray beam by interposing between x-ray tube and film a diaphragm. This sliding secondary diaphragm is easily constructed and easily attached to any of the commercial American tube stands. Under optical control, the diaphragm is adjusted so that for the high position of the tube it defines an x-ray beam barely overlapping the 14 by 17 in. film. Then the tube is moved to its low position and the diaphragm is slid slightly upward until optical control shows radiation barely overlapping the film. Although optical control is necessary as the apparatus is being first set up, once this has been done no further measurements of any sort are required. The technician adjusts film height to the patient's height and x-ray tube height to a scale calibrated so the mean position of the tube is at the height of the film center. He then cocks the tube down against the gravitational pull of its counterweight and slides the diaphragm up to the end of its travel and latches it there. When the first film of the pair has been made, a shift push switch is closed, activating a solenoid which releases the tube, allowing it to rise through the stereoscopic shift, and a second solenoid which releases the diaphragm, allowing it to slide downward, following which the second film is made. Although employment of this device with commercial tube stands seems complicated, any reasonably competent serviceman can make the apparatus and install it. From the diagram illustrated, it can be built in the simplest of machine shops and easily attached to commercial collimators. Alignment of the diaphragm is described and illustrated. (BBB)

13178 APPLICATION OF FLUORESCENT MICROSCOPY IN DIAGNOSIS OF DAMAGE BY IONISING RADIATION. Dusan Kolesar, Ondrej Ballog, and Jan Krizko (Komenskeho Universita, Bratislave). Pracovni Lekar., 16: 443-7(Dec. 1964). (In Czech.)

Clinically healthy subjects (45) who were occupationally exposed to ionizing radiation were examined by fluorescent microscopy. It was revealed that the percentage of nuclei with green fluorescence declines in a certain relation to the period of exposure to ionizing radiation: in the subgroup exposed for 6 months to 3 years it was 95.71%, in the sub-group exposed for more than three years it was 91.29%, while the average value in the control group was 98.7%. The revealed differences are statistically significant. Although these changes are not solely due to exposure to ionizing radiation, they may serve as a suitable supplementary method for the early diagnosis of long exposure or damage by ionizing radiation as they develop early and more frequently than other clinical and laboratory findings caused by prolonged exposure to ionizing radiation. (auth)

13179 THE TREATMENT OF EUTHYROID CARDIAC PATIENTS WITH RADIOIODINE AND ANTITHYROID DRUGS. H. L. Friedell, E. L. Schoeniger, and J. P. Storaasli (Western Reserve Univ., Cleveland). Progr. Cardiovascular Diseases, 5: 55-63(July 1962).

The observation that cardiac complications of sustained severe hyperthyroidism are corrected with the restoration of the patient to a euthyroid state has led to the proposal that euthyroid patients with severe heart disease might also benefit from suppression or abolition of their thyroid function. After the evaluation of several methods, a modification of the suppression of thyroid function by the use of radioiodine was introduced. This method depletes the thyroid hormone stores by the use of antithyroid drugs, permitting the use of a single therapeutic dose without the danger of sudden hormone release. Results of this method in 207 euthyroid patients are described. No transient increase in hormone release was observed; smaller total therapeutic doses were required to produce myxedema in the patients pretreated with anti-thyroid drugs; and the number of patients requiring retreatment was less. Seventy-six % of patients with angina showed worthwhile benefits of the treatment as compared to 56% improvement in congestive heart failure. The occurrence of radiation thyroiditis was not a serious problem, and it responded to symptomatic therapy with sedatives and analgesics. It usually occurs at the height of the radiation effect or seven to ten days after the treatment dose is given. The phenomenon of transient elevated hormone release was never observed, primarily due to pretreatment with antithyroid drugs. Occasionally it was necessary to confine the patient to bed during the critical period when radiation thyroiditis is at its height. The dosimetry of the therapeutic dose of radioiodine is considered in terms of the two most important parameters: size of the thyroid gland (which in euthyroid patients is usually normal) and effective half life of the radioiodine in the gland. It was concluded that about two thirds of the cardiac patients will benefit from the production of myxedema. (BBB)

13180 ON THE CALCULATION OF THE FOCAL DOSE AND THE LOCATION OF THE MAXIMUM DOSE IN PENDULUM IRRADIATION. B. Potschwadek (Universitat, Rostock, Ger.). Radiobiol. Radiother., 3: 591-9(1962). (In German)

The three ways to calculate the median focal dose are to use the average value of the instantaneous focal doses, the average of the focal dose differences, or the ratio of the focal dose differences. Each of these methods differ distinctly in accuracy, parameter accessibility, and applicability. The practicability and accuracy of these methods were evaluated, and the errors established from ~ 100 calculations. The method of calculation that used the instantaneous focal dose was found to be the most exact. In order to take advantage of the accuracy of this method the transverse diameter of the body section must be measured very closely. A tissue correction factor should be estimated from an irradiation procedure of the thoracic region. When the direction of the rotational point difference is estimated, the direction of the least focal difference or the bisected pendular angle should not be used. The angle at which half of the sum of the focal dose values is reached should be used. (TCO)

13181 Tc^{99m} PERTECHNETATE FOR BRAIN SCANNING. J. L. Quinn (Northwestern Univ., Chicago). Radiology, 84: 354-5(Feb. 1965).

The advantages of using ^{99m}Tc pertechnetate in brain scanning for the diagnosis of intracranial disease are compared with the use of ^{203}Hg or ^{197}Hg-chlormerodrin. It is pointed out that the 6 hr half-life and 140 kev γ emission give greater counting rates and reduce patient exposure. The preparation of ^{99m}Tc from a ^{99}Mo generator in the laboratory is described and the properties of the isotope are reviewed. (C.H.)

13182 INCREASED SENSITIVITY OF IN VIVO RADIOAUTOGRAPHIC FILMS. Norman B. Ackerman, Arthur S. McFee, and Arthur J. Madsen (Univ. of Minnesota, Minneapolis). Radiology, 84: 356-7(Feb. 1965).

The substitution of Vithane polyurethane for the original gum-rubber balloons increased the sensitivity of in vivo radioautographic balloons for gastric cancer diagnosis apparently by a factor of 3 to 4. The Vithane causes less desensitization of the radiosensitive emulsion than does the gum rubber. (auth)

13183 A NEW TESTIS PROTECTION DEVICE; THE TESTIS PROTECTOR-JOINTED DISK SHIELD. Friedrich Ekert, S. Stimpfl, and G. Beier (Stadtischen Krankenhauses, Munich). Roentgen Bl., 16: 369-77(Dec. 1963). (In German)

The testis protector-jointed disk shield consists of a set of hinged tongs with 18 cm long arms, with molded Pb plates above and below that have a Pb equivalent of 1 mm. These shield the testis against direct and scattered x radiation. The movement of the hinge is fixed in any position by an intermeshed clamping device that can be quickly shifted. Its action is regulated by a threaded control. The most important features in this equipment are the very long arms and the absence of a capsular form for the Pb covering, which is modelled completely to the body form, permitting rapid, exact adjustment. If the patient is disrobed, inexpensive paper covers can be placed between the plates and the skin. Damage to the bucky table surface by the jointed disk shield is prevented by rounding its edges and use of hammertone finish paint, or a rubber cover can be used. With the gonads within the radiation field this shield reduces exposure by 98%, and when the gonads are outside of the radiation field by a distance of ~5 cm the radiation exposure is reduced by 74%. With photographs of the pelvis and upper femur without any protection the incident gonadal dose is ~400 mr. With the jointed disk shield the gonadal exposure is reduced to only ~10 mr. (BBB)

13184 DIAGNOSTIC APPLICATION OF ^{60}Co-RADIOGRAPHY. Masao Okuhara (National Kanawawa Hospital, Japan) and Ikuro Tatsuno. Rinsho Hashasen, 9: 266-76 (Apr. 1964). (In Japanese)

Cobalt-60 radiography can be used, not only as a controling means such as in the collimation in the telecobalt treatment, but also as a diagnostic means. As ^{60}Co-radiography is a superhigh voltage photography, the contrast of bone and water becomes low, but the contrast of water and air is not so decreased. In a phantom experiment, which examined the contrast of water and air, the resolving power was nearly as good as that of the high voltage radiography in spite of a fairly large source used 2 × 2 cm. The advantages of ^{60}Co-radiography for the chest and skull are listed. It was concluded that ^{60}Co-radiography has the advantage of high voltage technique and of tomography on one film, and therefore it seems that it should be used widely in the clinical field in the futures. (NSA of Japan)

13185 ON DOSIMETRY FOR TELECOBALT THERAPY. Rudolf Birkner, Guenter Pohle, and Dietlof Puppe (Städt. Krankenhaus Moabit, Berlin). Strahlentherapie, 126: 1-13 (Jan. 1965). (In German)

A dosimetric method for telecobalt therapy is described, in which all measurements of the relative dose distribution in a phantom are related to a single dose or dose rate value. The advantages of selecting a single reference value for irradiation dosimetry are discussed. A reference value was selected, and its significance in both standing field and pendulum irradiation was demonstrated. (auth)

13186 THE SPATIAL DOSE DISTRIBUTION IN LARYNX REGION FOR PENDULUM IRRADIATION WITH TELECOBALT. Herbert D. Franke (Universität, Hamburg). Strahlentherapie, 126: 14-26(Jan. 1965). (In German)

Using a water phantom that was adapted to natural conditions, the isodoses for pendulum irradiation of carcinomas of larynx and hypopharynx were determined with telecobalt-kilocurie-machines. In early stages of the larynx carcinoma, the dose can be concentrated to the vocal cord region.

For late stages of the carcinoma of larynx and hypopharynx the spatial dose maximum can be adapted very well to size and site of the primary tumor; regional lymph node metastases receive about 50% of the focal dose and need additional irradiation. The tolerance limit of the cervical spinal cord must be considered. The dose distribution can be improved by asymmetrical pendulum angles, by controlled variation of speed (and field size) over segments, by pendulum irradiation using Pb-wedge filters, or by a combination of these methods. (auth)

13187 THE HEALING RESULTS ON BRONCHIAL CARCINOMA BY MEANS OF SIEVE IRRADIATION. Hiromu Kaneda, Morimasa Maeda, Takayuki Oku, Takatoshi Kobayashi, and Jiro Nakatsuka (Medical Academy, Kyoto). Strahlentherapie, 126: 27-41(Jan. 1965). (In German)

The results of treatment with conventional x-ray and telecobalt therapy in bronchial carcinoma after sieve irradiation are reported. Biological implications of the sieve method are discussed. (auth)

13188 COMPARATIVE INVESTIGATION ON MAN AND ON PHANTOMS OF THE ABSORPTION OF 200-kv X AND ^{60}Co GAMMA RADIATION. Rolf Frischkorn, Ulf Rosenow, and Prasiddhiporn Boon-Long (Universität, Gottingen, Ger.). Strahlentherapie, 126: 53-64(Jan. 1965). (In German)

Intravaginal determination of the tissue absorption from ^{60}Co and 200 kv x radiation as well as similar determinations with body cross section phantoms showed considerable deviations from an absorption assumed homogeneous. The individual surface form has a considerable influence. Telecobalt irradiation as compared with conventional types of radiation, does not give a better energy distribution in the tissue. The preferred forward scattering which offers advantages as the build-up effect and a relatively good beam limitation causes inhomogenities within the radiation beam after it has transversed tissues of different absorptions. (auth)

13189 RADIATION BURDEN AND PROTECTION OF THE GONADS IN UROLOGICAL X RAY DIAGNOSIS. R. Ueberall (Kaiser Franz Josef-Spitals, Vienna). Urol. Intern., 13: 230-5(1962). (In German)

Urological x ray studies of the abdominal area, intravenous urography, retrograde pyelography, cysto-urethrography, etc., impose a considerable radiation burden on the gonads. Similar diagnostic studies of the kidneys or other organs with x ray also expose the gonads to excessive radiation. For instance, two intravenous urographies, each with three exposures, two overall views, and a retrograde pyelography, including three exposures, will irradiate the gonads with 5346 mr. Protective shields for the gonads have been devised. These consist of plates, hoods, and capsules, constructed from 3-mm thick Pb. The capsules enclose the scrotum completely, and are available in two different sizes to provide a very close fit. The plate and hood have flexible, washable covers, and can be disinfected. The hood, used for men with exposures in the back position, is completely effective for direct radiation. It is 50% effective for protection against scattered radiation. For four exposures during a normal intravenous pyelography the gonadal exposure amounts to ~ 30 mr, which is equivalent to ~ 3 months of exposure to environmental radiation. For children, and for men where side and abdominal views are taken, the capsule gives almost complete protection. Shielding of women with the plates is sometimes incomplete, because of the large areas to be covered. The plates are constructed in sizes of 30 × 40, 24 × 20, and 30 × 40 cm. These sizes are versatile enough to shield the ovaries in ~ 50% of the studies made in the abdominal area, thus reducing the dose to the ovaries in the same proportion. In addition to the use of shields, radiation burden to the gonads can be reduced further by increasing the tube voltage, increasing the photograph distance, prefiltration, and use of improved film. (BBB)

13190 TEN YEARS OF INTRATUBAL IRRADIATION. Chl. Beck and H. H. Lau (Universitat, Freiburg i.B.). Z. Laryngol., Rhinol., Otol., 40: 957-64(Dec. 1961). (In German)

Intratubal irradiation is carried out in inoperable stenosed chronic otitis, with or without perforated drum. It is also carried out in cases of chronic catarrh of the middle ear, adhesive processes, and otoscleroses with impaired eustachian tube patency of various degrees. The applicator for intratubal irradiation resembles a catheter in form and size. The radiation applicator section is joined to the end of the tube by a flexible section located at the tapered end. The flexible section permits the applicator to be adapted to the individual tubal anatomy of each patient. Only β radiation is emitted through the walls of the Ni capsule, which contains 15 mC of ^{90}Sr–^{90}Y. The capsule is 15 mm long, with a dia of 1.7 mm. The wall thickness is 0.2 mm. The quantity of radioisotope used gives a dose of 1565, 840, 369, 156, and 69 R at tissue depths of 1, 2, 3, 4, and 5 mm, respectively, when applied for a 5-min interval. At a depth of 7 mm the dose is essentially zero. This type of treatment restricts the irradiation to the structures desired, and avoids the irradiation of surrounding tissue, such as the hypophysis, which occurs when x ray or ^{60}Co are used. The irradiation is carried for 0.5 hr or less, and its effects can be observed within 3 or 4 weeks. Initially, doses of 2400 R were used, but experience showed that 1600 R or less was sufficient. For patients with chronic middle ear catarrh dosages are graded according to the measured resistance within the tube. Thus, with tubal resistances of 40, 60, and 80 or more mm, the radiation dose administered is 900, 1200, and 1600 R, respectively. The applicator use time for these dosages is 3, 4, and 5 min. In very extreme cases this treatment can be repeated after an interval of no less than 4 weeks. These treatments should be used very cautiously in children under 14 yr of age, and only when the total development of the child is definitely endangered. Out of 383 eustachian tubes irradiated, 70% became freely patent. The only side-effects reported from this treatment have been slight impairments of hearing and tinnitus, but these disappeared rapidly. No delayed radiation injuries have been reported. (BBB)

13191 ON THE USE OF RADIOPHOSPHORUS (^{32}P) IN THE TREATMENT OF MALIGNANT TUMORS OF THE BLADDER. PART I. M. Bergmann (Universitat, Graz). Z. Urol., 57: 63-70(Jan. 1964). (In German)

Infiltration of bladder tumors with radiophosphorus is suggested as a supportive measure to be used in conjunction with surgical procedures. In advanced cases where the lymphatic vessels and nodes are involved and radical removal of the tumor is not possible, treatment with radiophosphorus is a way to provide local palliative treatment. After the tumor tissue is removed from the opened bladder by means of an electric knife, several 1-ml volumes, each containing 200 to 250 μC of ^{32}P are infiltrated into the basal tissue. Volumes larger than 1 ml are not retained well. In some cases where the tissues have been severely traumatized by the operation or have a poor blood supply because of multiple vascular ligatures, necrosis has been observed perivesicularly. Sometimes the radiophosphorus is infiltrated into the tissues in the course of biopsy procedures 5 to 8 days before operation. This procedure may reduce the possibility of metastasis of the tumor cells, and provide a protective barrier for the regional lymph nodes which will still be effective later when surgery is carried out. The ^{32}P is infiltrated through cannulae percutaneously from a suprapublic direction with a maximally filled bladder. Using a cystoscope, 6 to 8 cannulae can be controlled. The ^{32}P solution is infiltrated, and is followed by a saline solution. This method is superior to the transuretheral infiltration procedure since the tumor is more easily penetrated and several needles can be used simultaneously. Another advantage is that the operator needs no special shielding from the radiation. The irradiation is localized to the areas infiltrated, lasts for 3 weeks, and is not as destructive as that from radioisotopes of shorter half life. (BBB)

13192 ON THE USE OF RADIOPHOSPHORUS (^{32}P) IN THE TREATMENT OF MALIGNANT TUMORS OF THE BLADDER. PART II. M. Bergmann (Universitat, Graz). Z. Urol., 57: 121-33(Feb. 1964). (In German)

To improve the possibilities of success in the treatment of malignant bladder tumors colloidal ^{32}P solutions were infiltrated before and during operation. In addition to its local effect ^{32}P tends to prevent spread of tumor cells to regional lymph nodes. Distribution of the radioactive particles was studied postoperatively by sampling tissue from the tumor and regional lymph nodes. This was assessed autoradiographically. The ^{32}P was distributed in the areas where it had been infiltrated. Also, in many sections from the paraileac and paraaortal regions there was much radioactivity. This was observed even when metastases were already present in the lymph nodes. It is likely that this type of distribution is not restricted to ^{32}P but might also result from use of other radioisotopes that localize similarly in the lymph nodes. Its functional effect would depend on the patency of the lymphatic vessels, and might not be effective if the lymph nodes were extensively invaded by tumor cells. The patients studied did not suffer any generalized radiation injuries, but necrotic areas were observed sometimes. These required very long times to heal. Perifocal inflammation and mucosal necrosis observed in some cases was probably due to effects of the ^{32}P itself. (BBB)

13193 USE OF RADIOISOTOPES IN HEMATOLOGICAL TESTS. Rômulo Ribeiro Pieroni, V. Maspes, J. Kieffer, R. Carelli, M. A. Jamra, J. C. Barbério, and A. B. De Ulhoa Cintra (Universidade, São Paulo, Brazil). p.371-93 of "Use of Radioisotopes in Animal Biology and Medical Sciences. Vol. I." New York, Academic Press, 1962. (IEA-71) (In Portuguese)

A discussion on the calculation of blood volume by means of ^{51}Cr and ^{131}I human albumin is followed by an examination of the significance of such determinations for whole-body and venous hematocrit work and the sequestration of erythrocytes. In connection with a discussion of ^{51}Cr as a means of determining erythrocyte survival, the question of suitable analytical data processing techniques is raised and current methods are reviewed. It is also suggested that sample-taking procedures should be altered so as to allow for fluctuations in blood volume and to reduce the period over which samples are taken. The point is made that radioactive chromium, although extremely useful as a means of shedding light on cell-destruction processes, is not very effective for bringing out changes in connection with cell formation, a topic that can be conveniently investigated in conjunction with a study of iron-absorption behavior, or, even better, iron kinetics. On the subject of erythrokinesis, the relevant role is apportioned to the models adopted, data being treated in a variety of ways (depending on the different models used) and the influence of the model employed on the final results being clearly brought out. Suitable methods and technical modifications are suggested for obtaining results with a closer approximation to reality. Attention is also drawn to the value of analogue computers for the study of erythrokinesis. The discussion concludes with data based on clinical observations and determinations made over the last four years with the aid of ^{51}Cr and ^{59}Fe (nearly 400 survival measurements, 100 simultaneous blood-volume measurements with ^{51}Cr and iodinated human albumin, and complete erythrokinesis studies carried out on 100 patients). (auth)

CHEMISTRY

General

Refer also to abstract 14090.

13194 (AD-605560) RADIATION SCAVENGING OF ACETYLENE DISSOLVED IN LIQUID OXYGEN, PART 1. IN-PLACE CLEANING OF PIPING SYSTEMS, PART 2. Final Report. (Little (Arthur D.) Inc., Cambridge, Mass.). Dec. 30, 1961. Contract AF04(657)-475. 72p. $3.00(OTS).

Destroying acetylene dissolved in liquid oxygen by irradiation with gamma rays was investigated. It was found that 94-98% of the acetylene in a saturated solution of acetylene in oxygen was removed in 8 hours at a dose rate of 80,000 rads. On this basis calculations indicated that a 5 kilocurie source of ^{60}Co or a 7.8 kilocurie source of ^{137}Cs would prevent any build-up of acetylene in a 28,000-gallon tank for a 10-year period. The most effective means of removing or passivating hydrocarbon contaminants in missile handling systems were investigated. Various experimental methods— treatment with gaseous fluorine, fluorination in Freon solutions, electrochemical fluorination, and vapor phase degreasing with Freons— were investigated. It was concluded that vapor phase degreasing with Freons is the most promising means of cleaning a system, and a discussion is given of the various problems encountered in the use of this method. (auth)

13195 (BNL-8808) LIQUID FUEL SYNTHESIS USING NUCLEAR POWER IN A MOBILE ENERGY DEPOT SYSTEM. M. Beller and M. Steinberg (Brookhaven National Lab., Upton, N. Y.). Jan. 1965. Contract AT-30-2-GEN-16. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The advantages of methanol over ammonia as fuel in vehicles are outlined. Requirements are presented for the production of 1000 gallons/day of methanol. The problem of extracting the CO_2 from the air for reaction with electrolytic H_2 is simplified by compressing the air, and the adsorbent bed volume required is discussed. It is concluded that methanol synthesis in a mobile energy depot system is both feasible and attractive. (D.L.C.)

13196 (TID-20400) THE VISCOSITIES OF SOLUTIONS OF ACIDS IN TRI-n-BUTYLPHOSPHATE. A. S. Kertes (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science and Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry) and P. J. Lloyd (Union of South Africa. Atomic Energy Board, Pretoria). [Mar. 23, 1964]. Contract AT(30-1)-905. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The viscosity behavior of extract solutions of polybasic acids in TBP was studied and compared with that of the strong mineral acids. The behavior of citric, tartaric, malic, and oxalic acids was similar to that of mineral acids, while acetic acid was not. The results indicate that the factor determining the viscosity is the absolute size of the solute complex rather than ion-pair interactions. No explanation is given for the continued increase of viscosity at mineral acid concentrations above 1 M. (D.L.C.)

Analytical Procedures

Refer also to abstracts 13700 and 14214.

13197 (ANL-6771) CALORIMETRIC METHODS FOR THE ASSAY OF FUEL PINS AND RESIDUES. N. M. Lazar, S. Rosen, and A. B. Shuck (Argonne National Lab., Ill.). Nov. 1964. Contract W-31-109-eng-38. 35p. Dep.;$2.00(OTS).

The possibilities of using calorimetric methods for assay purposes in the Plutonium Facility and the EBR-II Fuel Reprocessing Facility were examined. Prototypes of twin-differential and rate calorimeters were assembled and experimentally investigated. These investigations indicate that calorimetric assay methods will be useful for these purposes. Based on results with the prototypes, more advanced calorimeters were constructed and are also described. (auth)

13198 (CNAEM-21(Pt.1)) NEUTRON ACTIVATION ANALYSIS OF ROMAN COPPER COINS FROM 250-500 A.D. PART I. Kurt Zuber (Turkey. Atomic Energy Commission. Cekmece Nuclear Research Center, Istanbul). Jan. 1965. 34p. Dep.(mn).

Copper coins belonging to the period 40 years before and till 200 years after Diocletian's money reform (A.D. 294) were analyzed for Ag, Au and Sb. As the Ag concentration varies by 500 : 1 emphasis has been laid only on the determination of how the concentration changes, not on the absolute value of the percentages. In general, the older coins have more Ag and Au than those minted later. The coins investigated can be ordered according to their Ag concentration in three groups: The first group (a) is consisted of coins just before or during Diocletian's rule, the second (b) of the time of his successor Constantine I, and the third of the time of Theodosius I (A.D. 395) and after. The silver concentrations vary in the three groups as 36 : 10 : 1, whereas the Ag/Au ratio as 2.7 : 1.9 : 1. As Au contents decrease together with Ag contents, it is concluded that gold was an impurity of silver which was added for some unknown reason to copper. Sb is not detected in the oldest coins, but it appears at Diocletian's time. As in most coins Sb contents do not vary much, even if the Ag contents vary by a factor of 40; it is concluded that Sb was not an impurity of Ag. An attempt is made to estimate the contents of the three metals. It is suggested to use the width at half-maximum intensity of a full energy peak of a γ-ray spectrometer record for the determination of intensities of lines which are superimposed on an unknown background. This method is applied to the 0.41 Mev ^{198}Au line. Also it is shown, from the shape of a line which is the resultant of two nonresolved lines, how the contributions of the two components can be found. As an example, the composite line of 0.51 Mev ^{64}Cu and the 0.56 Mev ^{122}Sb is discussed. (auth)

13199 (LA-3157) APPLICATIONS OF THE ELECTRON MICROPROBE TO CHEMICAL ANALYSIS. E. A. Hakkila, H. L. Barker, G. R. Waterbury, and C. F. Metz (Los Alamos Scientific Lab., N. Mex.). July 1, 1964. Contract W-7405-eng-36. 71p. Dep.; $3.00(OTS).

The electron probe x-ray microanalyzer is a versatile tool for the analysis of areas as small as 1 micron in diameter. Some applications to the investigation of sample homogeneity, diffusion studies, identification of sample composition, and identification of inclusions are described. (auth)

13200 (LA-3176) THE DETERMINATION OF PLATINUM IN URANIUM–PLATINUM ALLOYS BY ELECTROLYTIC DEPOSITION. Ross D. Gardner, Carter H. Ward, and William H. Ashley (Los Alamos Scientific Lab., N. Mex.). Sept. 1964. Contract W-7405-eng-36. 9p. Dep.; $1.00(OTS).

The electrolytic method for the determination of platinum was applied and critically evaluated for the determination of platinum in uranium–platinum alloys. It was established experimentally that this method gives excellent results when applied to alloys containing from 0.1 to 5.0 percent platinum. An average recovery of 99.9 percent with a relative standard deviation of 0.6 percent was obtained for the analysis of 55 sample solutions simulating uranium–platinum alloys in that range. (auth)

13201 (MLM-1217) MOUND LABORATORY PROGRESS REPORT FOR SEPTEMBER 1964. J. F. Eichel-

berger, G. R. Grove, and L. V. Jones (Mound Lab., Miamisburg, Ohio). Sept. 22, 1964. Contract AT-33-1-GEN-53. 29p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Gamma-gamma, alpha-gamma coincidence studies and conversion electron spectra studies have permitted establishment of a tentative nuclear energy level system for the lead-205 nucleus; the system is compatible with known spin and energy level assignments. Actinium in solution was separated from radioactive impurities in an ion-exchange column. Methods of removing non-radioactive impurities are being studied. The half-life of polonium-210 is being redetermined by the method of decaying pairs, primarily to test the method; the half-life is found to be 138.46 ± 0.10 days. Two pairs having counting rate ratios closest to unity were rejected. All other pairs yielded values which agreed with the true half-life; in each case, the absolute error was less than 1.6 times the computed probable error. The behavior of strontium-90 is significantly different from that of barium-140 with respect to desorption by acetone. Strontium-90 is more readily desorbed than barium-140 by acetone from either a nitrate residue or a chloride residue, but the difference is more pronounced with the nitrate. It is suggested that a residue adsorption separation of Sr from Ba is possible. The operating holdup of the 12-column, 10-stage, methane, thermal diffusion column system was lost as a result of a leak. Calculations were made on a rearrangement of the columns to replenish the inventory in a shorter time. Experiments with the carbon dioxide-carbamate system led to a redesign of the column top to reduce column holdup. The intensities and multiplicities of proton nuclear magnetic resonance absorption peaks in the compounds containing the two isotopes of C (atomic masses 12 and 13) can be used to determine the abundance of carbon-13 and the assignment of abundances to specific C atoms in organic molecules. A charcoal trap at liquid N_2 temperature reduced the tritium content of helium-3 from 2×10^{-8}% to about 9×10^{-11}%. An adiabatic demagnetization was made in the helium-3 thermometer dewar system. The salt was cooled, but the temperature of the sample could not be measured. Aluminum oxide was evaluated as a superleak material. The results showed a separation factor 4.5 for one experiment. This compares with separation factors of 10 to 20 with iron oxide as the filter material. Neon-22 drawoff was continued in the batch processing of intermediate material used for enriching neon-21. Calculations on the four-stage thermal diffusion column cascade showed highest performance of a flowing system at 900°C hot-wire temperature. Xenon isotopes are being equilibrated for the separation of xenon-136 in a five-stage thermal diffusion column system. The profile showed a change in the xenon-131 concentration from 14% to 0.8% from the top to the bottom of the cascade. To improve the calculation of transport properties in thermal diffusion columns the intermolecular potentials must be known more accurately. A proposed dual, chopped-velocity, selected-beam experiment is being evaluated using a mathematical model on a computer. The computer program was completed and initial run was made with negative results; using packet dimensions that can be obtained in the laboratory, the particles were so dilute that no collisions occurred. In order to design a suitable collector system for a quadrupole isotope separator (mass filter), the equation of motion of mass-44 ions in the quadrupole field was programmed for the IBM-1620 computer. Data points obtained were used to plot ion paths in the quadrupole system. A power and control circuit was designed for use with the experimental ion source. With this source and supply the electron cloud is confined to a narrow beam by a controlled magnetic field; thus, a well collimated ion beam is obtained. Twin bridge calorimeters are being used with an O_2 combustion bomb to determine heats of combustion. The results of more than 15 determinations ranged from 0.1 to 0.4% lower than the accepted value for the heat of combustion of standard benzoic acid. An instrument resolving time determination was added to the computations in 4π counting. This increases the accuracy of the counting without requiring additional accumulation of data. A method is being developed for determining tritium in helium-3 and krypton-85 in Xe by liquid scintillation counting. The gas is trapped in the scintillator solution by drawing the solution rapidly into a vial containing the sample at 10 cm pressure or less. Overall efficiencies were found to be energy dependent, and ranged from 1.1% to 1.7% for tritium and 20 to 30% for krypton-85. Analysis of Ta–W alloys are being investigated by conventional polarographic techniques. Sodium tungstate, at concentrations ranging from zero to 15 mg per 100 ml in 6 N HCl, yields a linear relationship between diffusion current and concentration (0.285 ± 0.005 a/mg) if the measurement is made at the half-wave potential. The Ta–W alloy is readily soluble in a solution of equal mixtures of HNO_3 and HF, but the fluoride has to be removed prior to polarographic analysis. Although Ta is not polarographically reducible, other problems arising from the dissolution of the alloy were encountered and are being investigated. Fifteen experimental polyurethane and epoxy adhesive films were evaluated at room temperature. Thirty months after casting, the tensile strength of the formulations had increased slightly from values recorded 12 months after casting; the percentage elongation also increased slightly. (auth)

13202 (NLCO-940(p.6.1-4)) ONE-PIECE ANODE-CUP ELECTRODES FOR THE CARRIER DISTILLATION EXCITATION OF IMPURITIES IN U_3O_8. A. J. Pardi and W. H. Dingeldein (National Lead Co. of Ohio, Cincinnati).

An investigation was made of a number of one-piece anode-cup electrodes. Various designs and graphite grades were tested. These electrodes are used in the analysis of impurities in a U_3O_8 matrix using the carrier-distillation technique. Evaluations of the one-piece electrodes were made relative to the conventional two-piece Scribner-Mullin electrode. (auth)

13203 (NYO-3276-8) HIGH-ALTITUDE BALLOON SAMPLING PROGRAM THIRD QUALITY CONTROL. A Progress Report. Fernando Bazan and Colin G. Sanderson (Isotopes, Inc., Westwood, N. J.). Dec. 15, 1964. Contract AT(30-1)-3276. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Analytical work performed in conjunction with the program is reported. During the report period four blank samples and four standard samples were analyzed for 12 nuclides each. A study of $^{89}Sr-^{90}Sr$ behavior was performed on four low-level samples in which the ^{89}Sr-to-^{90}Sr ratio was 0.23. Results of a calibration study involving ^{91}Y and ^{144}Ce are included along with a description of analytical procedures used in the sampling program. (J.R.D.)

13204 (SAN-8002(p.265-75)) PHILOSOPHY OF THE SODIUM RESISTIVITY METER. Pete Lindsey (Atomic Power Development Associates, Inc., Detroit).

A temperature-compensated resistivity meter for determining impurities in liquid sodium is described. (T.F.H.)

13205 (SAN-8002(p.276-85)) DEVELOPMENT OF A CONTINUOUS METER FOR OXYGEN IN SODIUM. H. Steinmetz and G. Stern (United Nuclear Corp. [Development Div., White Plains, N. Y.]).

The design of an electrochemical cell for monitoring the oxygen content in liquid sodium is described. The performance of various electrolytes and reference electrodes in this cell is discussed. (T.F.H.)

13206 (SGAE-BL-13/1964) ZUM SPURENELEMENTGEHALT NORMALER UND PATHOLOGISCHER MILZEN. (The Trace Element Content of Normal and Pathological Spleens). H. Frischauf, H. Altmann, and K. Kaindl (Österreichische Studiengesellschaft fur Atomenergie G.m.b.H., Vienna). Sept. 1964. 7p. Dep.(mn).

The concentrations of Cu, Mn, Zn, and P in normal and pathological spleen samples and RNA fraction from spleen were determined by neutron activation. The results were tabulated and compared with other values from the literature. (J.S.R.)

13207 (FTD-TT-64-592) PHOTOCALORIMETRIC DETERMINATION OF NIOBIUM. Sh. T. Talipov, R. Kh. Dzhiyanbaeva (Dzhiyanbayeva), et al. Translated from Uzbeksk. Khim. Zh., No. 4, 18-22(1963). 9p. OTS.

The method of photocalorimetric determination of niobium, with the aid of dioxide-3.4-phenol-4-azobenzine, permits the determination of niobium in the presence of significant quantities of tungsten, vanadium, nickel, silicon, rare earth materials and elements, aluminum cobalt, chrome, etc. The determination of niobium also does not interfere with the presence of a three-fold surplus of titanium and a five-fold surplus of tantalum. The maximal error does not exceed 4.1%. The method was used to analyze artificial mixtures of some alloys and niobium-containing ores. (auth)

13208 DETERMINATION OF THORIUM BY ACETONE EXTRACTION OF THE HEXATHIOCYANATOCHROMATE (III) COMPLEX. R. Ripan and I. Eger (Inst. of Chemistry, Cluj). Acad. Rep. Populare Romine, Studii Cercetari Chim., 13: 153-6(1962).

Because of the tendency to hydrolyze in alkaline solution, the complex of Th can be quantitatively precipitated only from acid solution. The reagent is prepared by heating $KSCN\text{-}Cr_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O$ (6 : 5) on a water bath for 2 hr, evaporating the mixture to dryness, and adding ethanol to dissolve the $K_3Cr(SCN)_6$. This is obtained as the tetrahydrate by recrystallization from ethanol. An acid solution of $Th(NO_3)_4$ is treated with pyridine until neutral, and an excess of $K_3Cr(SCN)_6$ solution (0.5 g for each 0.1 g of Th) is added to give the violet precipitate of hydrated $[Th(OH)Py_5]$ $[Cr(SCN)_6]$. The precipitate is collected on paper, washed with a little water containing one drop of pyridine, then with small portions of acetone, and convert into $Th(OH)_4$; this is calcined 1 to 2 hr at 900°C. The sensitivity of the method is 10 μg per ml; the error is ±1% for 0.01 to 0.1 g of ThO_2. Uranium, Co, and Fe must be removed. (Anal. Abstr., Vol. 2, No. 12, Dec. 1964)

13209 DIRECT SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN THE PRESENCE OF YTTRIUM, CERIUM AND THORIUM. P. Spacu and F. Popea (Chemical Research Center, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Chim., 11: 261-5(1963).

To a known volume of HNO_3 solution (containing ≃2 to 88 mg of U) add 2 ml of 0.1M-dichloroacetic acid–0.1M-Na dichloroacetate (1 : 1), and dilute to 10 ml. After mixing for 10 to 40 min, measure the extinction at 420 mμ (3-cm cell) against a reagent blank solution. The presence of an equivalent amount of Th, a 5-fold excess of Y, or a 10-fold excess of Ce does not interfere. (Anal. Abstr., Vol. 2, No. 12, Dec. 1964)

13210 THE TOTAL ISOTOPIC ANALYSIS OF WATER. Liviu Blaga, Lucia Blaga, Alexandra Chifu, and Tamara Ciobotaru (Inst. of Atomic Physics, Cluj). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 43-6(1964). (In Rumanian)

Determination of the isotopic concentration of hydrogen in water on the basis of density measurements yields erroneous results because the density is dependent on the concentration of both D and ^{18}O in the sample. Therefore, the measurements were carried out only after normalizing the ^{18}O concentration by bubbling SO_2 through the water. The isotopic exchange reaction $H_2{}^{18}O + S^{16}O^{16}O \rightleftharpoons H_2{}^{16}O + S^{16}O^{18}O$ results in a normalized $H_2{}^{16}O$. The total isotopic analysis on the basis of density measurements after normalization required the following steps: determination of the difference between the density of the non-normalized sample and the standard water (Δ_{total}); between the normalized sample and the standard water (Δ_p); between the standard normalized and the standard non-normalized water (Δ_s). The density difference due to the D content is then: $\Delta_D = \Delta_p - \Delta_s$ while that due to ^{18}O is: $\Delta 18_O = \Delta_{total} - \Delta_D$. (TTT)

13211 ISOTOPIC ANALYSIS OF WATER BY THE DIFFERENTIAL PYCNOMETRIC METHOD. Liviu Blaga, Lucia Blaga, and Alexandra Chifu (Inst. of Atomic Physics, Cluj). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 47-53(1964). (In Rumanian)

A method, designated as the differential pycnometric method, was developed to determine low concentrations of D_2 and ^{18}O in the natural concentration range by means of density measurements. Jena-glass pycnometers with 0.03 cm dia capillary extremities were used in the measurements, which could be carried out with an accuracy of ±1 yd (≈ 10^{-6} g/ml). One of the pycnometers was filled with the unknown sample, the other with the reference water (from the water main of the city of Cluj). The heights of the columns in the capillaries and the weights of the pycnometers were determined. After emptying them, the pycnometers were refilled in reverse order to the same height and weighed again. The isotopic concentration was calculated on the basis of the weight differences. Special care was taken to remove the entrained N_2 from the samples. Water obtained by burning methane gas, which was rich in ^{18}O and therefore had a higher density, was used as the unknown sample. The average difference between the reference water and the unknown sample was 6.04 yd. The temperature was kept constant within 0.001°C during successive weighings. (TTT)

13212 USE OF A ZEISS INTERFEROMETER FOR THE ISOTOPIC ANALYSIS OF WATER. Liviu Blaga, Lucia Blaga, and Alexandra Chifu. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 125-7(1964). (In Rumanian)

The difference between the indices of refraction of D_2O and H_2O, at 20°C and λ = 5893 Å, Δn = 0.005007, may be used to determine the isotopic composition of water. The interferometer is very useful for this type of measurement because it allows direct comparison of the indices of refraction of two liquids. The system described by I. Kirshenbaum employing white light was used for the measurements. In the 0 to 1 mole % D_2O range, it was found advantageous to use an optical path of 80 to 100 mm; this made it necessary to use relatively large samples. Before the measurements, the water samples must be purified until they have a conductivity below 2.5×10^{-6} $ohm^{-1}cm^{-1}$ because most usual impurities cause an apparent decrease of the D concentration, up to 0.3 mole % D_2O; others, such as CO_2, have an opposite effect. (TTT)

13213 ANALYSIS OF PETROLEUM PRODUCTS BY ABSORPTION OF RADIOACTIVE RADIATIONS. III. DETERMINATION OF HYDROGEN CONTENT BY COUNTING THE IMPULSES DUE TO ABSORPTION OF BETA-RADIATION. T. Balint (Hungarian Petroleum and Natural Gas Research Inst., Veszprem). Acta Chim. Acad. Sci. Hung., 41: 341-53(1964).

The modified method of hydrogen determination based on absorption of β radiation, where measurements were carried out by impulse counting, offered advantages over measurements with ionization chambers. The apparatus suggested consists of ^{90}Sr radiation source, a sample holder, and a methane flow counter for measurement of radiation intensity with a scaler attached. The periods belonging to a constant impulse count of samples of a constant surface density were measured. Investigation of the method of measurement elucidated the effect of freely chosen variables on the accuracy of the measurement. Calculations carried out in the accuracy proved that on using the apparatus and technique evolved, it is possible to determine contents of hydrogen with an error of ± 0.08% by weight of hydrogen. From the results of measurements with pure hydrocarbons it was concluded that methodical errors interfere with the measurements. (auth)

13214 ANALYSIS OF PETROLEUM PRODUCTS BY ABSORPTION OF RADIOACTIVE RADIATIONS. IV. CONTRIBUTIONS TO THE DETERMINATION OF ELEMENTARY COMPOSITION BY MEASURING THE ABSORPTION OF ^{55}Fe X-RAY. T. Balint (Hungarian Petroleum and Natural Gas Research Inst., Veszprem). Acta Chim. Acad. Sci. Hung., 41: 355-64(1964).

In the case of samples of a simple elementary composition, concentration measurements based on the absorption

of ^{55}Fe radiation may be used. The effects of freely chosen variables on the accuracy of measurement were investigated by using differential photometric correlations. For the method based on measurement of a constant impulse number it was found that the error function discloses a minimum value depending on the background intensity. When, in turn, the impulse number belonging to a constant period of measurement is established, the minimum of the error function appears at an extinction of 0.869. On comparing the accuracies of both methods, the former proved to be more accurate. The calculations carried on the accuracy of measurements of absorption of ^{55}Fe radiation gave information on the applicability of this analytical method. (auth)

13215 DETERMINATION OF DEUTERIUM OXIDE BY THE FALLING-DROP METHOD. Te-Chiu Chin and Tsing-Lien Chang (Peking Univ.). Acta Chim. Sinica, 29: 266-76(1963).

Butyl benzoate is proposed as a medium for the falling-drop method for determining ^2H_2O in dilute heavy water in the concentration range 0 to 10.5 mole % at 22 to 33.5°C. A mixture of butyl and isobutyl benzoates (≈ 1:1) can be used in the range 0 to 7 mole % at 21.5 to 26.5°C. Isobutyl benzoate can be used at 20.5°C in the range 0 to 4 mole % of ^2H_2O. Calibration graphs for these methods are given. (Anal. Abstr., Vol. 2: No. 12, Dec. 1964)

13216 IDENTIFICATION AND CHARACTERIZATION OF INCLUSIONS AND IMPURITIES IN COMMERCIAL HIGH-PURITY BERYLLIUM. J. D. Braun and R. J. DeSando (Monsanto Research Corp., Miamisburg, Ohio). Am. Soc. Metals, Trans. Quart., 58: 105-9(1965). (MLM-1232J)

Finished beryllium rod and beryllium powder were analyzed for impurities and inclusions. Several of the inclusions were analyzed in situ with an electron probe. Randomly selected inclusions were removed from rod, powder, and acid-dissolution residues and analyzed using the electron probe. In addition, impurities in the beryllium powder and residues after acid dissolution of beryllium powder were studied microscopically and with x-ray diffraction techniques. A modification of the radial distribution analysis was also employed. Iron, silicon, aluminum, and magnesium were present in considerable amounts in the high-purity powder. Titanium, calcium, and sulfur were found in some of the rods. (M.C.G.)

13217 A GLASSY-CARBON ELECTRODE FOR VOLTAMMETRY. H. E. Zittel and F. J. Miller (Oak Ridge National Lab., Tenn.) Anal. Chem., 37: 200-3 (Feb. 1965). (ORNL-P-464)

A new form of carbon known as glassy carbon was used as an indicator electrode in voltammetry. Glassy carbon is a gas-impermeable, electrically conductive material highly resistant to chemical attack. It is suitable for use over the potential range from about +1.2 to −0.8 volts vs S.C.E. in acid medium. Voltammetric studies were made of solutions of Ce(III), Ce(IV), Cr(VI), Fe(II), Hg(I), $Fe(CN)_6^{-4}$, Ag(I), Cu(II), and UO_2(II). For most of these ions a peak type wave that approaches ideality was obtained. The E_p and i_p values for these ions are for the most part reproducible under the conditions stated and appear to be analytically usable. The electrode was fabricated by molding glassy carbon into an epoxy rod with a central tube to permit an Hg contact. The assembly is rugged and the electrode requires no pretreatment or treatment between uses. In ease of fabrication and maintenance the glassy carbon electrode (G.C.E.) compares very favorably with the pyrolytic graphite electrode (P.G.E.) and other solid electrodes. (auth)

13218 QUANTITATIVE SEPARATION FOR MAGNESIUM, CALCIUM, AND STRONTIUM USING ZIRCONIUM MOLYBDATE ION EXCHANGE CRYSTALS. Milton H. Campbell (General Electric Co., Richland, Wash.). Anal. Chem., 37: 252-5(Feb. 1965). (HW-SA-3536)

Alkaline earths can be quantitatively separated on zirconium molybdate ion exchange crystals. Magnesium is eluted with 0.14M ammonium sulfate made up to 60 vol % methanol. Calcium is eluted with 0.2M NH_4NO_3 − 0.005M HNO_3, and strontium is eluted with 1M NH_4NO_3. The sample loading matrix may be between pH 2 and pH 12 and may contain limited quantities of (ethylenedinitrilo)tetraacetic acid (EDTA). The effects of diverse ions on the loading and elution phases of the separations are discussed. Chemical yields for magnesium, calcium, and strontium mixtures of varying compositions are presented. (auth)

13219 RADIOCHEMICAL DETERMINATION OF CARBON-LITHIUM BONDS IN LITHIUM-TERMINATED POLYMERS USING TRITIATED ALCOHOLS. D. R. Campbell and W. C. Warner (General Tire and Rubber Co., Akron, Ohio). Anal. Chem., 37: 276-80(Feb. 1965).

The carbon-lithium bond reacts rapidly and irreversibly with aliphatic alcohols to form a carbon-hydrogen bond. When the alcohols contain hydroxylic tritium, labeled products are obtained which usually may be isolated for radioassay. Excess alcohol is removable by washing with water if the tritium in the products is not labile. These conditions are realized in the case of polybutadienyllithium for which a quantitative radiochemical assay method was developed. The hydrogen kinetic isotope effect in the termination reaction is negligible as determined both by the analysis of polymers having known C−Li contents and by the titration technique. Results using the radiochemical method agree well with those by carboxylation. Precise reaction temperature control in the range of 25−65°C is not required and any of several alcohols may be employed. The method appears applicable in the presence of a number of common sample contaminants and to certain other anionic polymerization systems. (auth)

13220 SEPARATION AND DETERMINATION OF RHENIUM BY ANION EXCHANGE USING THE FLUORIDE-CHLORIDE SYSTEM. Silve Kallmann and Hans K. Oberthin (Ledoux and Co., Teaneck, N. J.). Anal. Chem., 37: 280-3 (Feb. 1965).

Rhenium is retained by Dowex-1, when various combination of solutions of HCl, HF, NH_4F, and NH_4Cl are passed through the resin bed to remove constituents of steels, high temperature alloys, refractory metals and alloys, also minerals and ores. The subsequent elution of rhenium with perchloric acid allows the gravimetric determination of rhenium as the metal, as the tetraphenylarsonium perrhenate, or the photometric determination using the thiocyanate complex. (auth)

13221 AN IMPROVED PORTABLE FLUORESCENT X-RAY INSTRUMENT USING RADIOISOTOPE EXCITATION SOURCES. J. O. Karttunen and Dale J. Henderson (Argonne National Lab., Ill.). Anal. Chem., 37: 307-9(Feb. 1965).

It was demonstrated that the radioisotope ^{147}Pm in an aluminum matrix and emitting bremsstrahlung radiation is a more universal excitation source for fluorescent x rays covering the elemental range Z = 19 through 92 than tritiated Zr. A krypton-methane sealed proportional counter is used for detection and resolution. The apparatus weighs approximately 10 lb and occupies a volume of ½ ft^3. Data on powders and alloys analyzed with the ^{147}Pm/Al source are tabulated. The samples included: CoO, NiO, ZrO_2, SnO, CeO_2, and PbO powders; portland cement; and Cr-Ni-Mo alloy. (P.C.H.)

13222 RADIOAUTOGRAPHY AND SCANNING OF THIN LAYER CHROMATOGRAMS OF RADIOACTIVE WATER-SOLUBLE SUBSTANCES. R. A. Schwane and R. S. Nakon (DePaul Univ., Chicago). Anal. Chem., 37: 315-16(Feb. 1965).

A satisfactory method for thin layer chromatograms of radioactive sugars and polyhydric alcohols, using silica gel and kieselguhr adsorbents, is described. A stock solution containing 11.2 g of polystyrene per 100 ml of benzene with dibutyl phthalate added as a plasticizer is poured over the developed plates, which lie horizontally on a bench top. The plates are allowed to gel and then placed in an oven at 70°C for half an hour to dry. They are then immersed in

water at 55°C for 5 min and removed. The polystyrene film is stripped off immediately by sliding a razor blade between it and the glass plate. After it is pressed flat, the film is ready for scanning or radioautography. (P.C.H.)

13223 THE SIMULTANEOUS DETERMINATION OF RHENIUM AND OSMIUM IN ROCKS BY NEUTRON ACTIVATION ANALYSIS. J. W. Morgan (Australian National Lab., Canberra). Anal. Chim. Acta, 32: 8-16(Jan. 1965).

A neutron activation method is described for the determination of rhenium and osmium in rocks. Radiochemical separations, by carrier techniques, are carried out using anion-exchange and solvent-extraction procedures. The results obtained for two molybdenites and the standard rocks G-I and W-I were compared with other published values. (auth)

13224 THE SIMULTANEOUS DETERMINATION OF RUTHENIUM AND IRIDIUM IN OSMIUM SPONGE BY NEUTRON ACTIVATION ANALYSIS. R. Gijbels and J. Hoste (Ghent Univ.). Anal. Chim. Acta, 32: 17-31(Jan. 1965).

A radiochemical separation procedure for Os–Ru–Ir is described based upon selective distillation. In sulfuric acid-hydrogen peroxide solution 99.999 to 99.9999% of the osmium can be distilled if reoxidation of the osmium with permanganate is applied. From sulfuric acid-sodium bromate solutions more than 99% of the ruthenium activity can be recovered. More than 99.995% of the iridium remains in the residue. The method was applied to neutron activation analysis of 10-mg samples of osmium sponge and allowed determination of traces of ruthenium down to approximately 10 ppm and of iridium down to 0.5 ppm. For lower iridium contents, second-order interference of the osmium had to be taken into account. The error was approximately 0.05 ppm after an irradiation period of 5 days at a flux of 4×10^{11} n/sec/cm^2. (auth)

13225 DETERMINATION OF LANTHANUM WITH N-BENZOYL-N-PHENYLHYDROXYLAMINE. B. Das and S. C. Shome (Presidency Coll., Calcutta). Anal. Chim. Acta, 32: 52-6(Jan. 1965).

N-Benzoyl-N-phenylhydroxylamine is proposed for the gravimetric determination of lanthanum at pH 6.4 to 7.2. The precipitates can be weighed directly or ignited to the oxide. By suitable pH adjustment, many metals can be separated from lanthanum, which can then be determined in the filtrates. Interferences of Ni, Cu, Zn, and Fe(II) are masked with cyanide. About 99.5% of the cerium present can be separated from lanthanum by precipitating cerium (IV) at pH 4.8 to 5.2. (auth)

13226 SPECTROPHOTOMETRIC DETERMINATION OF ALUMINIUM WITH CHROME AZUROL S. P. Pakalns (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Anal. Chim. Acta, 32: 57-63(Jan. 1965).

A comprehensive investigation of spectrophotometric determination of aluminum with chrome azurol S is described. No heating is required for color formation, and the method is considerably more reproducible and selective than either the eriochrome cyanine R or aluminon methods. In the presence of suitable masking agents, only Be^{2+}, Zr^{4+}, and F^- caused serious interference. A molar absorptivity of 21,500 at 567.5 mμ was found for the aluminium-chrome azurol S lake, with a relative standard deviation of ± 0.4% at the 20 μg Al level. Beer's law was obeyed from 0 to 1.2 μg Al/ml. (auth)

13227 AN ANION-EXCHANGE METHOD FOR THE DETERMINATION OF RARE EARTHS, THORIUM, AND URANIUM IN MONAZITE. B. J. Jangida, N. Krishnamachari, M. S. Varde, and V. Venkatasubramanian (Atomic Energy Establishment, Trombay, India). Anal. Chim. Acta, 32: 91-4(Jan. 1965).

Applications of ion-exchange techniques for the separation of the three important constituents of monazite (thorium, uranium, and rare earths) are discussed. Equilibrium studies were made using sulfate medium. Uranium was found to be completely adsorbed on the Dowex 2-X8 resin at acidities below 10^{-2}M. Thorium showed strong adsorption between 10^{-2} and 10^{-3}M H_2SO_4. The procedure for monazite analysis is described and results are discussed. (M.C.G.)

13228 THE DETERMINATION OF HYDROGEN IN SODIUM. J. A. J. Walker and H. Seed (Atomic Energy Authority, Culcheth, Lancs, Eng.). Analyst, 90: 19-23(Jan. 1965).

A method is described for determining hydrogen in sodium at the 1 ppm level and upwards. Additions of known amounts of hydrogen to sodium were recovered satisfactorily. The reproducibility of the method indicated a coefficient of variation of the order to 20% at the 0.5 and 1 ppm levels. (auth)

13229 RADIOACTIVATION ANALYSIS. NEW TECHNIQUE AT THE SERVICE OF BIOLOGY. Dominique Comar (Service Hospitalier Frederic-Joliot, Orsay, France). Bull. Inform. Sci. Tech. (Paris), No. 86, 3-10 (Sept. 1964). (In French)

The theory and technology of activation analysis are briefly summarized. Some examples of the application of activation analysis to biology are given to illustrate the significance of this technique in biological studies. The examples used are physiopathological studies based on the determination of iodine in biological media and a study on the indispensability of the oligoelement mercury. (J.S.R.)

13230 IODOMETRIC MICRODETERMINATION OF THALLIUM IN MATERIALS USED IN THE PREPARATION OF SCINTILLATION MONOCRYSTALS. Rudolf A. Gejc (Gorskii State Univ., Kharkov). Chem. Listy, 58: 1443-7 (1964). (In Czech.)

The sample is decomposed with acid, and mineralized to eliminate organic components; nitrate anions are removed. Concentrated sulfuric acid is used for this purpose. After this Tl is oxidized by Br in a slightly acid medium, and the trivalent form is produced in a buffered solution. Excess Br is removed by phenol or sulfosalicylic acid; after addition of NaI the eliminated I is titrated with thiosulfate, with starch as an indicator. (45 references). (OTS)

13231 ANALYSIS OF TWO-COMPONENT SYSTEMS BY β-RAY BACKSCATTERING. J. Klas (Inst. of Chemical Technology, Bratislava. Chem. Zvesti, 17: 498-503 (1963).

Equations are derived and a nomogram is presented for the determination of the smallest measurable amounts of binary alloys. The equations can also be applied to the determination of the concentration of Ca gluconate solutions. (Anal. Abstr., Vol. 2, No. 12, Dec. 1964)

13232 REPORT ON RAPID DETERMINATION OF IMPORTANT RADIONUCLIDES (^{89}Sr, ^{90}Sr, ^{131}I, AND ^{137}Cs) IN LIVING MATTER AND WATER. K. G. Bergner and P. Jaegerhuber (Chemische Landesuntersuchungsanstalt, Stuttgart). Deut. Lebensm.-Rundschau, Nos. 7 and 8, 207-10; 253-5(July-Aug. 1964). (In German)

The procedures used for the routine determination of ^{89}Sr, ^{90}Sr, ^{131}I, and ^{137}Cs in milk, water, and solid foods are reported. (J.S.R.)

13233 EMISSION SPECTROGRAPHY: A REFINED TECHNIQUE OF INVESTIGATION IN THE NUCLEAR FIELD. R. Trucco (CISE, Milan). Energia Nucl. (Milan), 12: 33-43(Jan. 1965). (In Italian)

Techniques and methods are reported on analytical applications of emission spectroscopy in the nuclear field. Topics are gas analysis in metals, isotope analysis with a particular emphasis on the determination of ^{235}U content in uranium, trace analysis of elements contained as impurities in nuclear materials, and considerations on the use of a laser beam as excitation source. A synthesis of results of the conference held at Exeter (July 2, 1964) on the detection limits in spectrographic analysis is given. (auth)

13234 EXTRACTION OF ANIONIC URANYL COMPLEXES FROM DILUTE SOLUTIONS BY MEANS OF

FOAM. C. J. Turi, A. Barocas, and F. Salvetti (Comitato Nazionale per l'Energia Nucleare, Rome). Gazz. Chim. Ital., 93: 1493-1502(1963).

Factors affecting extraction by ionic flotation in foams are discussed. The method was applied to the extraction of $U^{(VI)}$ from dilute carbonate solution with surface-active agents; the U from a solution of 12 mg of $UO_2(NO_3)_2 \cdot 6H_2O$ (I) in 150 ml was concentrated into 1 to 2 ml of foam. The solution was placed in a glass cylinder (30 cm × 8 cm) with a gas inlet and a fritted glass disc at the bottom, and, at the top, a vertical exit tube (60 cm × 2 cm), bent over at its upper end so that the foam could be collected in a beaker. Varying amounts of 10% ammonium carbonate (II) solution and 10% benzethonium chloride (III) solution were added to the U solution, N saturated with H_2O was passed through at the rate of 75 ± 5 ml per min, and the foam was collected and analyzed. The U was converted by II into $[UO_2(CO_3)_3]^{4-}$, which combined with III, and, under appropriate conditions, were completely extracted in the foam; III was the only satisfactory foaming agent. A known volume of foam was evaporated on a disc of filterpaper, which was then ignited at 600°C; U was determined in the residue with a ZnS scintillation counter. The III in the foam was determined spectrophotometrically at 270 mμ. Optimum conditions for complete extraction were — I, 12.5 mg; ratio of I to II, 1:4; III, 0.3 g; H_2O, 125 ml; pH 8. Fractions of foam taken hourly showed a mole ratio of III to $[UO_2(CO_3)_3]^{4-}$ of 4:1. The U was extracted only in the anionic form. Chromatographic analysis showed that the anion formed with III a compound analogous to that formed with Dowex 1 and 2. (Anal. Abstr., Vol. 2: No. 12, Dec. 1964)

13235 NEUTRON ACTIVATION DETERMINATIONS OF BROMINE IN SOME GEOCHEMICAL STANDARDS. R. H. Filby (Univ. of Oslo). Geochim. Cosmochim. Acta, 29: 49-51(Jan. 1965).

A neutron activation method was developed for accurate determination of bromine in rocks, with a sensitivity of 4×10^{-10} g bromine. Some bromine determinations in international geochemical standards are described. (M.C.G.)

13236 THE USE OF ACTIVATED CARBON FOR DETERMINATION OF RADIUM IN WATER. A. A. Polynkova, I. N. Titova, and Yu. V. Novikov (Moscow Scientific-Research Inst. of Hygiene). Gigiena i Sanit., No. 11, 69-70 (Nov. 1964). (In Russian)

Four brands of activated carbon were examined to determine their suitability for the detection of Ra in water from the main supply system at the concentration level of 0.48×10^{-12} g/lite. The method involves acidification with HCl to a pH of 2.0, 3.0, 4.0, 5.0, and 6.0, followed by addition of $CaCl_2$ and Na_2CO_3. The Ra was coprecipitated with Ca under addition of the activated C, allowing the sample to stand for a day, and then filtering and washing the precipitate, which was sealed for a specific period, then subjected to counting by means of scintillation α-counter determining the Ra on the basis of the Rn. The sensitivity threshold of the ZnS-lined instrument was 3 to 4×10^{-13} Curie for the 10 minute period. Results of 195 tests indicated that for the Brand A purified activated carbon and for animal carbon, the largest amount of Ra can be detected at pH values between 3.0 and 6.0 while the optimum range for Brand B and ground carbon was between pH of 3.0 and 4.0. Only 62 to 75% of the Ra could be found when the pH was kept between 5.0 and 6.0 and at pH = 2.0 the detectable amount ranged only from 26 to 54% of the Ra present. The method is recommended for radiological assays. (TTT)

13237 DETERMINATION OF CERIUM IN STEEL. L. Brhacek and K. Kurzova (Research Inst. VZKG, Ostrava, Czechoslovakia). Hutnicke Listy, 18: 663-4(1963).

Dissolve the sample (2 g) in 10 ml of HNO_3 (1:1) plus 15 ml of concentrated $HClO_4$, and evaporate to incipient crystallization. Add H_2O (30 ml), boil briefly, cool, and add 10 to 40 ml of $(NH_4)_2SO_4 \cdot FeSO_4 \cdot 6H_2O$ (I) solution. Transfer the solution to a polyethylene beaker, dilute with H_2O to 80 ml, add concentrated HF (20 ml), stir thoroughly with a platinum stirrer, add filter-paper pulp, and collect the precipitated CeF_3 on a double filter-paper. Wash the precipitated 8 to 10 times with H_2O, dry, and ignite filter and precipitate in a platinum crucible. Fuse the residue with $K_2S_2O_7$ (1 g), dissolve the cooled melt in 5 ml of H_2SO_4 (1:1), transfer the solution to a beaker dilute to ≃40 ml, add 5 ml of 1% $AgNO_3$ solution and 10 ml of 25% $(NH_4)_2S_2O_8$ solution, and boil to decompose the excess of persulfate. Cool, and titrate potentiometrically with 0.005N-I. Steels high in Cr are dissolved in aqua regia (20 ml). For samples containing >0.2% of Ce, the error was ±0.01%. (Anal. Abstr., Vol. 2, No. 12, Dec. 1964)

13238 DETERMINATION OF C^{14} AND TRITIUM IN BLOOD AND OTHER BIOLOGICAL MATERIALS. M. A. Tamers and M. Diez (Instituto Venezolano de Investigaciones Cientificas, Caracas). Intern. J. Appl. Radiation Isotopes, 15: 697-702(Dec. 1964).

A sample convertor was designed that is capable of accepting any type of substance containing ^{14}C or tritium, without preliminary treatment, and transforming it, quantitatively, to another chemical compound that can be counted with precision by liquid scintillation techniques. Results are presented to demonstrate the producibility of the convertor for ^{14}C and tritium determinations. A further advantage of the method is illustrated by tests showing its capability of removing a variety of other isotopes present in the original sample that would interfere with the ^{14}C determinations. (P.C.H.)

13239 USE OF THE ČERENKOV COUNTER IN THE DETERMINATION OF OXYGEN BY NEUTRON ACTIVATION ANALYSIS. H. R. Lukens and J. E. Lasch (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Intern. J. Appl. Radiation Isotopes, 15: 759-62(Dec. 1964).

The use and some advantages of the Cherenkov detector for measuring ^{16}N activity in the activitation determination of oxygen are described. One advantage consists of the relative insensitivity of the counter to both γ rays and weak β particles. Therefore, it is possible to effect a measurement of the 10.4 Mev (max) β particles from ^{16}N with little interference from even very high levels of competing activity. Also, the resolving time of the counter is on the order of only 10^{-10} sec. The apparatus and experimental procedure are described. (P.C.H.)

13240 LIQUID SCINTILLATION COUNTING OF BLOOD. A. C. Houtman (Philips-Duphar Research Labs., Weesp, Netherlands). Intern. J. Appl. Radiation Isotopes, 16: 65-70(Feb. 1965).

Several methods are compared for liquid scintillation counting of blood samples. The radioactive products are extracted from the blood either directly with the scintillation solvent system Polyether 611 or with solvents such as dioxane or ethanol. The last-mentioned extracts are counted in a hyamine-Cl-toluene system. Blood contacted with peroxides, if any, in the Polyether 611 gives rise to chemoluminescence, often causing extremely high and unstable background values. Conditions for counting at normal background values were determined. Contents from 0.01 nc ^{3}H or 0.003 nc ^{14}C per ml blood are thus detectable. (auth)

13241 THE DETERMINATION OF THORIUM IN CERIUM MATRICES BY NEUTRON IRRADIATION: USE OF THE ARGONNE PNEUMATIC FACILITY. G. W. Smith and D. M. Morgan (Argonne National Lab., Ill.). Intern. J. Appl. Radiation Isotopes, 16: 81-9(Feb. 1965).

A method for the determination of thorium in cerium matrices was developed. After sample dissolution, thorium is separated from cerium by anion exchange in 10 M nitric acid and elution with dilute ammonium EDTA-nitrate solution. The separated sample, encapsulated in polyethylene, is irradiated in a pneumatic tube and the γ rays of ^{233}Th are counted. The standard error of the method was found to be ±7%, with a bias of +4% as determined by the method of standard addition. A maximum sensitivity of 0.01 ppm thorium in cerous chloride and 0.1 ppm in other cerium compounds was indicated. The Argonne pneumatic tube-facility (rabbit laboratory) at CP-5 is briefly described and the portable hood philosophy is discussed. (auth)

13242 EXPOSURE OF AN ISOTOPE EFFECT BY ^{3}H-LABELED FATTY ACIDS ON SILICA-SILVER NITRATE CHROMATOGRAPHY. D. S. Sgoutas and F. A. Kummerow (Univ. of Illinois, Urbana). J. Chromatog., 16: 448-53 (Dec. 1964).

A tritium isotope effect was observed during the chromatography of tritiated unsaturated fatty acids as their methyl esters on silica-silver nitrate columns. The results are interpreted in terms of the coordination complexes formed between olefinic bonds and silver ions. (auth)

13243 ION EXCHANGE PROCEDURES. VI. CATION EXCHANGE OF Ac(III) AND Fr(I) IN HCl AND $HClO_4$ SOLUTIONS, ISOLATION OF ^{227}Ac FROM ^{231}Pa AND ^{227}Ac DAUGHTERS. Frederick Nelson (Oak Ridge National Lab., Tenn.). J. Chromatog., 16: 538-40(Dec. 1964). (ORNL-P-408)

The cation exchange behavior of Ac(III) and Fr(I) in HCl and $HClO_4$ solutions is described and a method for isolating ^{227}Ac from its daughters and from ^{231}Pa is presented. (auth)

13244 A METHOD OF DETERMINING CARBON^{14} AND SULFUR^{35} IN BIOLOGICAL SPECIMENS UTILIZING THE CRYOSTAT. Donald E. Flieder (St. Louis Univ.). J. Oral Therap. Pharmacol. 1: 313-15(Nov. 1964).

Of the many methods for counting the relatively weak β emissions of ^{14}C and ^{35}S in biological materials, each exhibits certain disadvantages depending on the counting equipment and the sample preparation. A convenient and reliable method is described for determining ^{14}C and ^{35}S in biological specimens which utilizes the cryostat. Tissues are quickly removed from the animal, frozen in liquid nitrogen, and cut at a knifeblade temperature of −15°C. The sections are transferred to a glass cover slip, and may be lyophilized or dried on a warming table before counting with a Geiger-Müller system. Specimens are centered in the planchet to obtain uniform counting geometry. A major advantage of this method is that specimens of reasonably uniform thickness may be prepared and, after counting, the specimen may be used for further studies, such as histochemistry, cytochemistry, and autoradiography. Also, it is not necessary to correct for self-absorption provided the sections are cut very thin, i.e., less than 25 μ. An example of the method is illustrated with tissues from mice injected intraperitoneally with either 10 μC of glycine-^{14}C or 60 μC of $Na^{35}S = O_4$. After 80 min their livers were removed and a portion frozen directly in the cryostat. Another portion of liver was homogenized. Up to a thickness of 25 μ, the specific activity of ^{14}C and ^{35}S were 4.95 and 3.04, respectively, and in the homogenates 5.34 and 3.63. Experiments utilizing glycine-^{3}H were not a success; erratic values were frequently observed presumably due to the self-absorption of the weak β emissions. (TCO)

13245 SEPARATION OF URANIUM FROM SCANDIUM, YTTRIUM, RARE-EARTH ELEMENTS, THORIUM, BERYLLIUM, MAGNESIUM, COPPER, MANGANESE, IRON, ALUMINIUM AND OTHER ELEMENTS BY CATION-EXCHANGE CHROMATOGRAPHY. F. W. E. Strelow (South African Council for Scientific and Industrial Research, Pretoria). J. S. African Chem. Inst., 16: No. 2, 38-47(1963).

Uranium can be eluted by $\underline{N}$-H_2SO_4 from a column of AG 50W-X8 resin, which retains Sc(III), Y(III), La(III) and the rare-earth elements, Th(IV), Al(III), Ga(III), Fe(III), Fe(II), Be(II), Mg(II), Mn(II), Cu(II), Co(II), Ni(II), Zn(II), and Cd(II). Separations are very satisfactory for ratios of U to other elements from 100:1 to 1:100. Quinquevalent V, Mo(VI), and Nb(V) can be separated from U by elution with 0.5$\underline{N}$-H_2SO_4 containing H_2O_2; under these conditions, U is retained by the resin. (Anal. Abstr., Vol. 2: No. 12, Dec. 1964)

13246 AN IMPROVED GAS-LIQUID RADIOCHEMICAL CHROMATOGRAM FOR C-14 AND TRITIUM. A. T. James and C. Hitchcock (Unilever Research Lab., Sharnbrook, Bedford, Eng.). Kerntechnik, 7: 5-8(Jan. 1965). (English)

An improved gas-liquid radiochemical chromatograph is described in which the effluent from the column is converted to carbon dioxide and hydrogen. Mass (determined as hydrogen by a catherometer) and activity (determined by proportional counter) are recorded automatically and continuously. Less than 1 μg of fatty acid ester and 1 nC of C^{14} are easily detected; the apparatus is simple, sensitive, and cheap. A method for the localization of radioactivity in the fatty acid molecule is also described. This depends on controlled oxidation to a mixture of homologous fatty acids followed by radiochromatography. (auth)

13247 QUANTITATIVE ANALYSIS BY MEANS OF DOUBLE FOCUSING MASS SPECTROGRAPH FOR SOLIDS. PART II. J. Kai and M. Miki. Mitsubishi Denki Lab. Rept., 5: 411-21(Oct. 1964).

The relative sensitivity coefficient for an element in spark source mass spectrometry is discussed, and the coefficients of several elements in the matrices of Al, Fe, Ti, and Cu were determined. The variations of measurement were about ± 50%, and no significant evidence of matrix effect was seen. Some correlation between relative sensitivity coefficient and heat of sublimation and ionization potential of the element are discussed. Data are tabulated. (P.C.H.)

13248 DETERMINATION OF TRACES OF GADOLINIUM IN HIGHLY PURIFIED GRAPHITE BY EMISSION SPECTROGRAPHIC ANALYSIS. Hisao Ohsawa and Masahiko Umezu (Fuji Electric Co., Ltd., Kawasaki-shi, Japan). Nippon Kagaku Zasshi, 86: 59-62(Jan. 1965). (In Japanese)

A method for determining traces of gadolinium in highly purified graphite, applicable to the range from 0.03 to 0.25 ppm was established on the basis of an emission spectrographic procedure. Standard samples were prepared with highly purified graphite, gadolinium chloride, 0.6 ppm of germanium oxide as an internal standard, and 2% sodium fluoride as a spectrographic buffer substance. A d-c arc technique was used to excite the elements. The experimental conditions for excitation were 20 amp, 280 v, and 60 sec in argon atmosphere. The analytical gap was 8 mm and the light of emission was measured about 6 mm from the anode side. The intensity ratios of Gd: 3100.50 Å/Ge: 3039.06 Å, Gd: 3362.24 Å/Ge: 3039.06 Å were found to be proportional to the gadolinium content and were used for the determination. The experimental error of this method was 10%. (auth)

13249 DETERMINATION OF MAGNESIUM AND MERCURY BY RE-ACTIVATION ANALYSIS. Yuichiro Kamemoto and Shigeru Yamagishi (Japan Atomic Energy Research Inst., Tokyo). Nippon Kagaku Zasshi, 86: 74-7 (Jan. 1965). (In Japanese)

Re-activation analysis was applied to the determination of magnesium and mercury. This method consists of: irradiation for 6 min for Mg or 4 min for Hg; radiochemical separation; measurement of the γ spectra of ^{27}Mg or ^{205}Hg; cooling for a sufficient time to allow the decay of ^{27}Mg or ^{205}Hg, ^{197m}Hg, and ^{197}Hg activities; re-irradiation of the counting sample for 3 min for Mg or 20 min for Hg; cooling; and measurement of the γ spectra of ^{27}Mg or ^{197}Hg. The content of magnesium or mercury in the sample can be determined by the activity of ^{27}Mg or ^{205}Hg and ^{197}Hg produced by the first and second irradiations. (auth)

13250 ADVANCES IN ACTIVATION ANALYSIS. J. M. A. Lenihan (Western Regional Hospital Board, Glasgow). Nucleonics, 23: No. 2, 65-6, 68, 70-1(Feb. 1965).

Advances in neutron activation analysis are discussed. A sealed-tube neutron source was developed, which gives outputs of 10^{10} neutrons/sec and has a longer target lifetime. Improved techniques are described and examples given. Medical and biological uses are also discussed. (M.C.G.)

13251 INVESTIGATION ON THE PRECIPITATION OF URANIUM CONCENTRATE FROM SOLUTIONS OF ELUTION ION EXCHANGE RESINS. Stefania Domanus (Inst. of Nuclear Research, Warsaw). Nukleonika, 9: 863-70(1964). (In Polish)

An investigation was made on the precipitation of uranium concentrate from acidic solutions after etching the uranium

ore with sulfuric acid and separation of the solid suspension. Precipitation was done by means of gaseous ammonia and heating to over 600°C. The end product U_3O_8 was accompanied by impurities of which the phosphate ion was the most troublesome. The laboratory technique described varies somewhat depending on whether the phosphate content in the eluate is negligible or excessive. Actual experimental results are tabulated and plotted showing the effectiveness of ammonia in the sedimentation phase and in the subsequent filtration phase of the process. The effect of phosphate content on loss of uranium precipitation was also measured. Experiments were further conducted on a semi-technical scale with $FeCl_3$ added before precipitation in order to combine and thus eliminate the phosphate ion. (ATD)

13252 THE EXTRACTION OF NEPTUNIUM BY MEANS OF HYDROXYLAMINE DERIVATIVES. A. V. Lapitskii, N. P. Rudenko, and Gavad Aaed Abdel. Radiokhimiya, 6: 617-19(1964). (In Russian)

An investigation was made on the extraction of neptunium by means of several hydroxylamine derivatives (benzohydroxamic acid, benzoyl phenylhydroxylamine, and neocupferron) as well as the effect of butylamine on this process. Neptunium-239 was obtained by irradiating 30 mg of uranium in the form of U_3O_8 for 48 hours in a reactor with $0.87 \cdot 10^{13}$ neutrons/cm^2 · sec. The separated neptunium isotope was oxidized to the pentavalent state by a sodium nitrite solution. The radiochemical purity of the isotope was checked by a measurement of its half life, which was found to equal 2.3 days. During the extraction studies, neptunium was placed in a test tube with the buffer solution, and shaken in a thermostat at 25°C for 30 minutes with the extracting agent. After shaking, measurements were made of the activity of the aqueous and organic phases, while the pH of the solutions was determined on a potentiometer. Of the reagents studied only benzohydroxamic acid failed to extract neptunium under the conditions described. Extraction by means of neocupferron took place at lower pH values than in the case of benzoyl phenylhydroxylamine. It was discovered that complete extraction of neptunium requires the presence of butylamine in the water phase. Also, neocupferron, while it does have a large dissociation constant, is inferior to benzoyl phenylhydroxylamine because of poor solubility and instability. (TCO)

13253 GAMMA SPECTROMETRY AND ACTIVATION ANALYSIS. PRINCIPLES AND METHODS. PART I. C. Brooke and E. Peeters (Universite Libre, Brussels). Rev. M.B.L.E., 7: 188-213(Sept. 1964). (In French)

Elementary concepts on radioactivity, radiation, and nuclear reactions are reviewed. The principles of gamma spectrometry are introduced, and the problems and analytical methods for identification of the components of radioactive mixtures are detailed. The different methods described are illustrated by experimental examples. (tr-auth)

13254 AMMONIUM PHOSPHOMOLYBDATE AS ION-EXCHANGER FOR RADIOACTIVE CESIUM DETERMINATION IN RAIN WATER. Augusto Jorge Ribeiro da Fonseca, Maria Helena Dias de Matos, and Maria Manuela da Cruz Godinho (Junta de Energia Nuclear, Sacavem, Portugal). Rev. Port. Quim.(Lisbon), 6: 17-21(1964). (In Spanish)

The properties of ammonium phosphomolybdate as cationic exchanger for the alkali metals were used for the determination of ^{137}Cs in rain water collected in Sacavem. The method used and its bases are discussed. (auth)

13255 DETERMINATION OF POTASSIUM IN VARIOUS FISH PRODUCTS WITH THE OBJECT OF MEASUREMENT OF THE RADIOACTIVITY OF THOSE FOODS. Jean Morre and Jean Barret (Service Veterinaire de la Prefecture de Police, Paris). Rev. Trav. Office Sci. Tech. Peches Maritimes, 27: 235-40(1963). (In French)

A flame photometric method was used to determine the natural potassium content in fresh-water and marine fish, crustaceans, and mollusks. The results were tabulated and show that K/g of dry material is relatively constant in both marine and fresh-water animals. (J.S.R.)

13256 DETERMINATION OF MICRO- AND MACRO-AMOUNTS OF RARE-EARTH ELEMENTS. A. A. Fedorov, F. A. Ozerskaya, and F. V. Linkova. Sb. Tr. Tsentr. Nauchn.-Issled. Inst. Chernoi Met., No. 31, 197-9(1963).

A method is proposed for the separation of Ce from Fe, based on the selective adsorption of $FeCl_6^{3-}$ by the strongly basic resin Dowex 1-X4 (Cl^- form) from solution 8N in HCl. The Ce in the perchlorate is titrated with EDTA solution, with arsenazo I as indicator. The Fe is eluted from the column with dilute HCl and determined with $Cr_2O_7^{2-}$. The method was used to determine Ce in alloys. Results of the complexometric determination of 22.8 to 28.0% of Ce agree to within 0.2% with those obtained by the oxalate method. As well as ion exchange, the following methods were tested for the separation of mixtures of rare-earth elements and Fe—extraction of Fe with acetylacetone or isopropyl ether; removal of Fe with thioacetamide; extraction of rare-earth elements with tributyl phosphate; and precipitation of Ce on silica gel at pH 6. All the methods were laborious or insufficiently effective. (Anal. Abstr., Vol. 2: No. 12, Dec. 1964)

13257 EXTRACTION OF RARE-EARTH ELEMENTS. A. K. Lavrukhina, L. V. Yukina, and Z. V. Khromchenko. Tr. Komis. po Analit. Khim., Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim., 14: 202-8(1963).

The extraction of Ce(III), Nd, Pm, and Eu by 2-thenoyltrifluoroacetone(I) solution in benzene was studied as a function of the metal concentration in the aqueous phase and the concentration of I in the organic phase by using the radioactive isotopes ^{144}Ce, ^{147}Nd, ^{147}Pm, ^{153}Sm, and ^{155}Eu. At constant concentration of Pm in the presence of Nd, and with extraction by 5M-I in benzene, the percentage extraction of both Nd and Pm was reduced as the concentration of Nd was increased up to 100 mg per ml. A synergistic effect was observed in the extraction of La, Ce, and Eu by solution of I and tributyl phosphate in $CHCl_3$. (Anal. Abstr., Vol. 2: No. 12, Dec. 1964).

13258 EXTRACTION-PHOTOMETRIC DETERMINATION OF YTTRIUM AND LANTHANUM WITH ALIZARIN RED S. L. S. Serdyuk, U. F. Silich, and V. A. Smirnaya. Tr. Komis. po Analit. Khim., Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim., 14: 271-8(1963).

Complex formation between Y or La, Alizarin red S (C.I. Mordant Red 3) (I) and phenazone (II) was studied. In the presence of NH_4^+, Y forms with I a colored compound extracted by butanol, isobutyl alcohol, or tributyl phosphate; the optimum pH for the extraction is 4.8. Under these conditions, La does not form an extractable compound; Ce(IV) forms such a complex, but it is masked by H_2O_2, so that Y can be determined in the presence of La and Ce. Procedure: add an aliquot of test solution to 1.5 ml of 0.1% I solution, add 10 ml of 4% H_3BO_3 solution, and dilute to 25 ml. Then add 3.3 ml of 4.88N-aqueous NH_3 and 4 drops of 30% H_2O_2 solution, mix well, add 15 ml of butanol, and shake for 1 min. Measure the extinction (green filter) of the organic phase in a 2-cm cell, with water as comparison solution, and subtract a blank reading. The method was used to determine Y in minerals. With I and II, La forms a 1:1:1 complex with an extinction maximum at 540 mμ; the optimum pH is 4.5 to 5.5. In determining La, the calibration graph is constructed by adding 0.2 to 0.8 ml of mM-$LaCl_3$ and 0.7 g of II to a mixture of 1.2 ml of 2mM-I, 2.5 ml of 0.5M-H_3BO_3 and 3 ml of acetate buffer solution (pH 5), diluting to 12 ml with the buffer solution, extracting the La for 1 minute with 15 ml of isobutyl alcohol or butanol and, after 5 to 10 min, measuring the extinction of the extract at 40°C as described above. Beer's law is obeyed for 10^{-6} to 6×10^{-6} g-atom of La per liter. (Anal. Abstr., Vol. 2: No. 12, Dec. 1964)

13259 AUTOMATIC EXTRACTION-PHOTOMETRIC DETERMINATION OF URANIUM. P. N. Palei, A. A. Nemodruk, and A. V. Davydov. Tr. Komis po Analit. Khim., Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim., 14: 281-91(1963).

The method is based on the continuous extraction of U by a 20% solution of tributyl phosphate in carbon tetrachloride

from an aqueous solution previously treated with twice its volume of 60% NH_4NO_3 solution (pH 3) containing 0.2 to 0.5 g of EDTA per liter and chloroacetate buffer solution. The extraction is carried out in a counter-current rotor extractor; the U is re-extracted in a similar extractor with 0.015% arsenazo(III) solution, and the extinction of the extract is measured. The error in determining ∮0.1 μg of U per ml is ∮5%. The following elements, in concentration (expressed as a multiple of the U concentration) up to that given in parentheses, do not interfere—rare-earth elements (10), Zr and V (50), Fe, Mo, and W (200), Th (300), Be and Mn (1000), Al and Ca (5000), Cu, Ni, Co, and Zn (8000), Cr^{6+} and Cr^{3+} (10,000), F^- (400), PO_4^{3-} and citrate (1000), Cl^- and SO_4^{2-} (10,000), and acetate (1500). The determination of U in organic solution requires only the extraction with arsenazo(III) solution. The determination takes 13 to 15 min with aqueous solution and 7 to 10 min with organic solution. The apparatus used is described in detail. (Anal. Abstr., Vol. 2, No. 12, Dec. 1964)

13260 NEUTRONENAKTIVIERUNG ALS ANALYTISCHES HILFSMITTEL. (Neutron Activation as an Analytical Method). Werner Schulze. Die Chemische Analyse. Band 50. Stuttgart, Ferdinand Enke Verlag, 1962. 331p. (Paper cover (DM 75); Cloth-bound (Dm 79).

The theory and practice of neutron activation and an analytical method is discussed. The production of neutrons, irradiation and its effects, the radiation from radionuclides, radiation measurements, detection and identification of elements, chemical operations, special methods for determination of some elements, and review of activation analyses described in the literature are discussed. (J.S.R.)

13261 NEITRONNYE METODY POISKOV I ANALIZA BORNOGO SYR'YA. (Neutron Methods in Prospecting and Analysis of Boron Deposits). V. I. Baranov, V. L. Barsukov, V. F. Ivanova, and V. K. Khristianov. Moscow. Publishing House "Nauka," 1964. 139p.

A review is given of neutron methods for determining the boron content of various materials. The neutron absorption method and equipment for neutron recording in laboratory absorption analysis are discussed. Neutron well logging, neutron boronometric sampling and assaying of ore deposits, and neutron detectors for determining the boron content in liquid media are also discussed. (R.V.J.)

13262 THE SOLVENT EXTRACTION OF METAL CHELATES. Jiri Stary. A Pergamon Press Book. New York, The Macmillan Company, 1964. 252p.

Information is included on composition and stability of metal chelates; theory of the solvent extraction of metal chelates; analytical applications of the solvent extraction of metal chelates; systems, such as β-diketones, oximes, nitrosophenols, etc.; and selective extraction procedures for individual metals. Data on dissociation constants, partition coefficients, and solubility of organic reagents that form extractable chelates are appended. 1271 references are included. (P.C.H.)

13263 ASSAY OF ^{235}U IN NUCLEAR REACTOR FUEL ELEMENTS BY GAMMA-RAY SCINTILLATION SPECTROMETRY. N. S. Beyer (Argonne National Lab., Ill.). 4p. (CONF-630905-2)

From 4th International Conference on Non-Destructive Testing, London.

Principles of gamma-ray scintillation spectrometry are described. A technique used at Argonne is described whose calibration is almost completely independent of destructive tests. Comparison is made of fuel plate loading determinations by this technique and other methods. (D.L.C.)

13264 THE DETERMINATION OF LEAD IN BLOOD AND URINE BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Eleanor Berman (Illinois Masonic Hospital, Chicago). 4p. (CONF-640908-1)

From 11th Ottawa Symposium on Applied Spectroscopy and Analytical Chemistry, Ottawa.

A method utilizing atomic absorption is described for the determination of lead in blood and urine. A simple extraction procedure is used providing a method which is rapid and relatively free of interferences. The method is proven by recovery experiments and by comparison with dithizone colorimetric determinations. A considerable number of blood and urine samples, both pathological and normal, were analyzed, and the spread of data reported. (auth)

13265 THE DETERMINATION OF COPPER, IRON, LEAD, AND ZINC IN NICKEL PLATING SOLUTIONS BY ATOMIC ABSORPTION. Robert G. Shafto (Hanson-Van Winkle-Munning Co., Matawan, N. J.). 3p. (CONF-640908-3)

From 11th Ottawa Symposium on Applied Spectroscopy and Analytical Chemistry, Ottawa.

Copper, iron, lead, and zinc at the ppm level are determined in nickel plating solutions by atomic absorption. The analysis for all four metals is rapid and dependable. The sample preparation requires only dilution. (auth)

13266 DETERMINATION OF VARIOUS METALS IN SILICATE SAMPLES BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Dorothy J. Trent and Walter Slavin (Perkin-Elmer Corp., Norwalk, Conn.). 8p. (CONF-640908-4)

From 11th Ottawa Symposium on Applied Spectroscopy and Analytical Chemistry, Ottawa.

The accuracy of metal determinations in silicates was tested by analyzing a number of National Bureau of Standards samples by atomic absorption spectrophotometry. In addition, strontium, not previously reported in this matrix by atomic absorption, was determined. Copper at very low concentrations was determined by a simple extraction procedure. (auth)

13267 TESTS WITH PYROLYTIC GRAPHITE PLATE ELECTRODES. G. Zotov. 18p. (CONF-640908-2)

From 11th Ottawa Symposium on Applied Spectroscopy and Analytical Chemistry, Ottawa.

Experiments on the use of pyrolytic graphite plates as supporting electrodes in emission spectroscopy, primarily for dried residue excitation techniques, are described. Methods for machining of plates, applying sample solutions, and excitation are given. Spray coating of plates under various conditions is compared with coatings obtained with a deposition of a single drop by conventional methods. Results to date show coefficient of variation for reproducibility of element determination of about 4%. (auth)

13268 ACTIVATION ANALYSIS IN THE PHARMACEUTICAL INDUSTRY. David G. Kaiser (Upjohn Co., Kalamazoo, Mich.). 11p. (CONF-138-3)

From 11th Detroit ANACHEM Conference, Detroit, Oct. 1963.

The utilization of activation analysis by the pharmaceutical industry has been limited to problems which cannot rapidly be resolved by current instrumental or wet chemical methods. Although presently not used on a routine basis, the technique has been successfully applied to the determination of trace elements in process samples as well as final products containing both organic and inorganic matrices. Specific attention has been focused on the processing of antibiotics and steroids. Most of the investigations have been conducted with thermal neutrons and short-lived radioisotopes having half lives of less than 15 minutes. However, with the commercial availability of relatively low-cost high-flux portable generators, these studies can be expanded to include fast neutrons and other accelerated particles. Gamma spectrometry in conjunction with a rapid radiochemical separation is the preferred method of analysis but valuable data have been obtained, in selected cases, by using gamma spectrometry alone. Potential applications for the analysis of cobalt, copper, fluorine, and manganese in pharmaceutical, biochemical, and pharmacological studies are considered. (auth)

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Refer also to abstracts 13897, 13901, 13964, 14264, 14269, and 14270.

13269 (AD-60829) STUDY OF BURGERS' EQUATION OF THE KINETIC THEORY FOR A REACTING GASEOUS MIXTURE. Ting Yi Li (Cincinnati. Univ. Research Foundation). July 1964. Contract Nonr 2168(03). 15p. (AE-6402)

Burgers obtained an extended form of the Boltzmann equation which adequately takes into account of chemical reactions and diffusion in a realistic kinetic model of the reacting gaseous mixture. By certain approximate arguments, this Burgers' equation can be reduced into a simplified model equation. This simplified model equation is formally in agreement with an earlier equation also proposed by Burgers. (auth)

13270 (ANL-6902) ENGINEERING DEVELOPMENT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART 6. PREPARATION OF DENSE URANIUM DIOXIDE PARTICLES FROM URANIUM HEXAFLUORIDE IN A FLUIDIZED BED. Irving E. Knudsen, Norman M. Levitz, and Albert A. Jonke (Argonne National Lab., Ill.). Dec. 1964. Contract W-31-109-eng-38. 31p. Dep.; $2.00(cy), 1(mn) CFSTI.

A fluid-bed process for the preparation of dense, spheroidal uranium dioxide particles directly from uranium hexafluoride for dispersion and compacted fuel element applications was developed. In the process, uranium hexafluoride is reacted with mixtures of steam and hydrogen in a bed of uranium dioxide fluidized by the reactant gases and maintained at 650 to 700°C. The solid reaction products deposit as a dense layer on the surface of the bed particles. The operating procedure involves alternating periods of uranium hexafluoride feed with periods of fluoride cleanup when only steam and hydrogen are fed. Product is withdrawn at the end of each cleanup period. Seed particles may be added to offset the growth of the particles in the bed and allow a uniform average particle size to be maintained. The feasibility of an in-situ method of seed preparation, in which the reduction of bed particle size is obtained by oxidative fracturing of the UO_3 particles, was established. Uranium dioxide particles in the size range −18 +140 mesh and having densities up to 9.75 g/cc (89% of theoretical density) were produced. Uranium hexafluoride feed rates in the range from 17 to 50 g/min [30 to 88 lb uranium/(hr)(ft² reactor cross section)] were tested, the higher rates giving a product of somewhat lower density (~ 9 g/cc). The average residual fluoride content of the product was about 250 ppm. Steam/uranium hexafluoride mole ratios proved to be another important variable, ratios of about 2:1 giving material of the highest density. The effect on uranium dioxide density of other process variables, such as hydrogen concentration, bed depth, and location of the uranium hexafluoride inlet, was also determined. Densification of the uranium dioxide particles to about 10.5 g/cc (96% of theoretical density) and reduction of the fluoride content to about 5 ppm was achieved by sintering in hydrogen at about 1700°C. (auth)

13271 (ASD-TDR-63-881) THE DEBYE CHARACTERISTIC TEMPERATURE OF SOLIDS. F. W. Vahldiek (Research and Technology Div. Air Force Materials Lab., Wright-Patterson AFB, Ohio) and A. M. Vahldiek (Research and Technology Div. Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio). Aug. 1963. 17p. (AD-422458). $0.75(OTS).

The Debye characteristic temperature as derived from Einstein's equipartition law is compared with frequency distribution functions of Born, Blackman and Lindemann. Debye theta values determined by mechanical and thermodynamic measurements for the rather simple elemental solids show differences. The following methods for deriving the Debye characteristic temperature for solids are discussed: specific heat, electric resistance, x-ray diffraction, high pressure, mechanical, and infrared. Debye temperature measurements for certain anisotropic and refractory solids such as SiO_2, TiO_2, and graphite are included. An attempt was made to calculate the "average" Debye theta for ZrO_2 and HfO_2. (auth)

13272 (CEA-R-2567) ETUDE ELECTROCHIMIQUE DANS L'EUTECTIQUE FONDU SULFATE ACIDE DE SODIUM–SULFATE ACIDE DE POTASSIUM. (Electrochemical Study in the Molten Sodium Acid Sulfate–Potassium Acid Sulfate Eutectic). Francois Le Ber (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1964. 71p. Dep.(mn).

Thesis submitted to Université, Paris.

The general properties of the $NaHSO_4$–$KHSO_4$ molten eutectic resemble those of neutral sulphates and those of concentrated H_2SO_4. The existence in solution of the ions HSO_4^-, SO_4^{2-}, and H_3O^+, the latter being formed by the action of the HSO_4^- ions on dissolved H_2O. The electro-active zone with a polished platinum electrode is limited in oxidation by the ions H_3O^+ and SO_4^{2-}, and in reduction by the protons of HSO_4^-. The electro-active zones obtained with different electrodes (Ag–Au–graphite–mercury) were compared. The dissolution of a few metallic oxides and halides is considered. This work shows the role as O^{2-} ion acceptors of HSO_4^- ions. An electro-chemical study of a few oxido-reduction systems was undertaken: H^+/H_2, Ag/Ag (I), the vanadium and uranium systems, those of mercury Hg/Hg_2^{2+} and of gold Au/Au^{3+} then of the attack by the solvent of a few common metals such as aluminum, iron, copper and nickel. The study of silver systems has made it possible to obtain the solubility products of AgCl and AgBr and to consider the possibility of titrating coulometrically Cl^- ions with Ag^+ ions. The existence of various chemical species of vanadium which may exist in the molten eutectic is shown. (auth)

13273 (DP-913) ORGANIC COMPOUNDS OF THE ACTINIDES AND LANTHANIDES. A Compilation of Data in the Literature. Linda Lou Smith (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1964. Contract AT(07-2)-1. 43p. Dep.; $2.00(OTS).

A table of properties was compiled for some organic compounds of the actinide and lanthanide elements. The tabulated properties include appearance, melting points, boiling points, solubility data, stability, and molecular complexity. The majority of the compounds are β-diketone complexes, alkoxides, cyclopentadienides, or derivatives of these classes. (auth)

13274 (GEAP-4544) THE OXIDATION OF ANION-DEFICIENT ZIRCONIA AND ITS RELATIONSHIP TO THE OXIDATION OF ZIRCONIUM. D. L. Douglass and Carl Wagner (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 31, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 20p. (EURAEC-1269). Dep.(mn); $1.00(cy), 1(mn) OTS.

The parabolic rate constant, k_p, for the oxidation of anion-deficient zirconia, $ZrO_{2-\delta}$, was determined for pure and doped monoclinic zirconia from 450 to 900°C. A detailed theoretical analysis showed that the rate constant was a complex function of the diffusion coefficient of oxygen vacancies according to the relation $k_p = \frac{3\pi D_\square}{2}\left[\frac{\delta^{\bullet\bullet}}{\delta_0^{\bullet\bullet}}\left(1 + \ln\frac{\delta^{\bullet\bullet}}{\delta^{\bullet}}\right)\right]^2$ where $D_\square$ is the diffusion coefficient of oxygen vacancies, δ_0 is the initial oxygen deficit in the anion-deficient oxide, $\delta^{\bullet\bullet}$ is the oxygen deficit at which the mol fraction of free electrons equals the mol fraction of anion vacancies, and $\delta^{\bullet}$ is the oxygen deficit at which the partial conductivities of ions and electrons are equal. The theoretical analysis of the diffusion behavior indicated that the diffusion coefficient of oxygen (a) was independent of oxygen partial pressure (and composition) at pressures between the equilibrium dissociation pressure of the oxide and $P_{O_2}^{\bullet}$, (b) is dependent upon $P_{O_2}^{\bullet}$ at pressures between $P_{O_2}^{\bullet}$ and $P_{O_2}^{\bullet}$, and (c) is independent of pressure (but equal to the diffusion coefficient of free electrons) over the range of $P_{O_2}^{\bullet}$ to atmospheric pressure. The parabolic rate constant, k_T, for the oxidation of unalloyed zirconium is given by $k_T = \frac{3D_\square\delta_{eq}}{2}$ where δ_{eq} is the oxygen deficit of the oxide in equilibrium with zirconium. The ratio of k_p to k_T is

then given by $\frac{k_P}{k_T} = \frac{\pi}{\delta_{eq}} \left[\frac{\delta^{\bullet\bullet}}{\delta_0}\left(1 + \ln \frac{\delta^{\bullet\bullet}}{\delta^{\bullet}}\right)\right]^2$. The effect of doping was to increase the values of $\delta^{\bullet\bullet}$ and $\delta^{\bullet}$ provided the mol fraction of dopant exceeded the mol fraction of anion vacancies. In this case $\delta^{\bullet\bullet}$ is the oxygen deficit at which the excess electron concentration equals the anion vacancy concentration at $P_{O_2} = 1$ atm. Yttrium additions increased the parabolic rate constant for zirconia oxidation by a factor of 300. This behavior is in agreement with the fact that Zr–Y alloys oxidize more rapidly than unalloyed Zr. (auth)

13275 (IS-1042) PACK2—A FORTRAN CRYSTALLOGRAPHIC MOLECULAR PACKING PROGRAM. Donald E. Williams (Ames Lab., Ames, Iowa). Nov. 1964. Contract W-7405-eng-82. 33p. Dep.; $2.00(OTS).

A computer program is described which performs an analysis of molecular packing in crystals. All space group symmetries are allowed. The packing energy of a molecular crystal structure, known or proposed, may be evaluated using appropriate nonbonded interatomic potential functions. For unknown crystal structures, the program may be used to assist the solution of the diffraction phase problem. In this application the program minimizes the packing energy for a molecule of assumed dimensions by a steepest descent method. The adjustable parameters are the molecular translations and rotations, specified internal molecular rotations (subrotations), and the lattice constants. The program may also be used to study nonbonded interatomic potential functions. These functions can be evaluated by a comparison of the calculated parameters found by the program with the observed parameters for known crystal structures. (auth)

13276 (LA-3162) METHOD FOR HIGHLY ACCURATE NUMERICAL SPATIAL INTEGRATION: APPLICATION TO LATTICE DYNAMICS OF CUBIC TYPE CRYSTALS. W. C. Overton, Jr., and A. F. Schuch (Los Alamos Scientific Lab., N. Mex.). Aug. 30, 1964. Contract W-7405-eng-36. 49p. Dep.; $3.00(OTS).

The vector-interpolation method for machine computation of the frequency distribution $G(\nu)$ of lattice vibrations is greatly improved and extended. A procedure is developed which permits one to design an exactly uniform N-vector distribution (for any N) inside one of the typical $\frac{1}{48}$ symmetry-irreducible trihedral solid angles which characterize highest cubic symmetry. The value N = 489 was chosen for reasons discussed, and given a table of direction cosines $p_\varkappa, q_\varkappa, r_\varkappa$ to ten decimals of the $\varkappa = 1, 2, \ldots, N$ vectors. It is shown that by permutations and sign changes of these $p_\varkappa, q_\varkappa, r_\varkappa$ one can generate an exact uniform distribution of 23,472 vectors to the full 4π steradians. Thus, the results may find application in several areas outside lattice dynamics. An analysis is made of the errors committed in calculating $G(\nu)$ by the vector-interpolation method. The effect on the error of anisotropy of the constant-frequency surfaces inside the Brillouin zone is found. A sample calculation is made for a face-centered cubic lattice model for the highly anisotropic frequency surface of an important Van Hove critical point frequency. It is found that the accuracy of $G(\nu)$ improves by a factor of 66 to better than 1 in 10^4 upon increasing N from 70 (used in earlier work) to 489. Many Debye θ's were calculated with N = 489, and comparison with de Launay's tables (N = 70) provides the basis for further assessments of the effect of anisotropy upon accuracy. The requirement for the high accuracy obtainable with N = 489 in a new regime of anharmonicity calculations is discussed. (auth)

13277 (LA-3184) IDEAL GAS THERMODYNAMIC FUNCTIONS OF LANTHANIDE AND ACTINIDE ELEMENTS. Roy C. Feber and Claude C. Herrick (Los Alamos Scientific Lab., N. Mex.). Dec. 1, 1964. Contract W-7405-eng-36. 37p. Dep.; $2.00(cy), 1(mn) CFSTI.

Experimental and, in some cases, predicted energy level data are used to calculate the thermodynamic functions of the gaseous monatomic lanthanide elements cerium through lutetium and the gaseous monatomic actinide elements thorium through curium over the temperature range 100 to 6000°K. (auth)

13278 (NYO-10295) I. FURTHER INVESTIGATIONS ON THE STABILIZATION OF AQUEOUS SUSPENSIONS OF THORIUM OXIDE. II. AN ULTRA-HIGH RADIOFREQUENCY SPECTROMETER FOR THE STUDY OF AQUEOUS SOLUTIONS AND SUSPENSIONS. Progress Report, March 1, 1960–August 31, 1962. Robert H. Smellie, Jr. (Columbia Univ., New York). Oct. 15, 1962. Contract AT(30-1)-2267. 34p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Results of studies concerning factors affecting the stability of aqueous suspensions of ThO_2 are discussed. It was found that the stabilizing effects of adsorbed species (such as silicate and CuO) are greatest when the ThO_2 surface contains about one absorbed molecule or ion for every four Th atoms on the surface. Pre-ignition of ThO_2 at 450°C for two hours promotes the formation of stable suspensions, and deposition of CuO, NiO or similar oxides on ThO_2 surfaces produces suspensions that are stable at high temperatures and pressures. Work in an investigation of the possibility of using radiofrequency absorption to study ThO_2 suspensions is also discussed. Results obtained using radiation at 500 to 900 Mc on samples of dry powdered oxides and metals, aqueous solutions, and suspensions of metallic oxides in water are presented. (J.R.D.)

13279 (ORNL-P-925) THE ABSORPTION SPECTRA OF H_2O AND D_2O IN THE NEAR INFRARED REGION AS A FUNCTION OF TEMPERATURE FROM −20° TO 250°C. W. C. Waggener, A. J. Weinberger, and R. W. Stoughton (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 14p. (CONF-650401-2). Dep.(mn); $1.00 (cy), 1(mn) OTS.

From American Chemical Society, Detroit.

In studies of spectra of water in the condensed states between 0.7 and 2.0 μ, measurements were made of the temperature dependences of the broad $(2\nu_1 + \nu_3)$ and $(\nu_1 + \nu_2 + \nu_3)$ absorption bands of H_2O and D_2O in ice to 20° below the freezing point, in the supercooled liquid to 15° below the freezing point, and in the liquid from the freezing point to 250°C and ca. 39 atm. At 250°C, the additional bands, $(\nu_1 + \nu_3)$, $(2\nu_2 + \nu_3)$ and $(\nu_2 + \nu_3)$, were observed in saturated and superheated H_2O steam. The spectra of H_2O and D_2O are qualitatively similar; however, the D_2O bands occur at longer wavelengths by a factor of 1.35, are broader, more complex, less intense, and generally less temperature sensitive. Part of these differences may stem from 0.2 mol % H_2O in the D_2O used. The observed frequency shifts of both the $(2\nu_1 + \nu_3)$ and $(\nu_1 + \nu_2 + \nu_3)$ bands in the following condensed phases from the frequencies of these bands in the dilute gas (literature values) are about −1.7% for liquid at 250°C; −2.1% for liquid at 100°C; −5.1% for liquid at 0°C; −5.9% for liquid at −15°; −8.4% for ice at 0°; and −9% for ice at −20°. This environmental sensitivity of water spectra, attributed primarily to intermolecular H-bonding, is 25 to 30 times that observed for similar near-infrared spectra of CO_2, in which van der Waals forces appear to govern the bulk properties. (auth)

13280 (TID-21569) THERMODYNAMIC PROPERTIES OF SOLID SOLUTIONS AT HIGH TEMPERATURES. Progress Report, January 10–December 31, 1964. Arnulf Muan (Pennsylvania State Univ., University Park. Coll. of Mineral Industries). Contract AT(30-1)-2781. 24p. Dep. (mn); $1.00(cy), 1(mn) OTS.

Activity coefficient-composition graphs for Pt–Ni, Pt–Co, Pt–Fe, Pt–Mn, Pd–Ni, Pd–Co, and Pd–Fe alloys at 1200 to 1500°C show that the deviations from ideal behavior in the Pt and Pd alloys increases with decreasing atomic number. Emf measurements in PbO–SiO_2 melts were used to derive activity-composition graphs for Pb in Pt–Pb and Pd–Pb alloys at 850 to 1200°C. Free energies of formation at 1150°C are given for Mn_2SiO_4 (tephroite), $MnSiO_3$ (rhodonite), and $FeSiO_3$ (ferrosilite), and a ternary diagram is given of the activities in the system FeO–MnO–SiO_2 at 1150°C. Other studies of metal oxide

systems completed or in progress are reported. The occurrence of two solid solution series in the CoO–MnO–SiO_2 system is reported. Some phase studies in the MgO–FeO–SiO_2 system are also described. (D.L.C.)

13281 (TID-21622) A STUDY OF A NEW THORIUM COMPOUND AT LOW pH. Technical Report No. XXIV. Byong D. Chun and Milton E. Wadsworth (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Dec. 1, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 2176. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Colloidal thoria converts to another compound at a low pH upon heating for a long time. The compound was separated from the mother liquid, and washed with absolute alcohol. Its composition was determined by chemical analysis and infrared spectra. According to the infrared spectra, there were no free OH bonds in the compound, so that the final formula of the compound was determined as $ThOCl_2 \cdot 14H_2O$. This hydrated thorium oxychloride is easily hydrolyzed in a neutral or weak acidic solution. (auth)

13282 (UCRL-11605) APPARATUS FOR MOLECULAR BEAM STUDIES OF CHEMICAL DYNAMICS. Kent Raymond Wilson (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 15, 1964. Contract W-7405-eng-48. 134p. Dep.; $4.00(OTS).

A description is given of some of the apparatus and in studies of elastic and reactive scattering of thermal-energy molecular beams. "Big Bertha", the general crossed-beam machine, is described in some detail along with the massfilter detection system. An outline of the experimental procedure for measuring elastic and reactive angular distributions is given. The modulated beam apparatus used to reduce noise and the test stand are also described. Graphs are presented for the vapor pressures of beam materials. (D.L.C.)

13283 (UCRL-11850) THE THERMOCHEMISTRY OF DI- AND TRI-VALENT EUROPIUM (thesis). John L. Burnett (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 18, 1964. Contract W-7405-eng-48. 65p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The construction and operation of a semi-adiabatic microcalorimeter are discussed in detail. The heat of solution of europium metal in 0.1 N HCl was measured and is -164.6 ± 1.0 kcal/mole. This value is combined with available thermochemical data to calculate: $\Delta H^0_{Eu^{+3}} = -130.4 \pm 1.0$ kcal/mole. The preparation and properties of europium monoxide, prepared by reacting the metal with the sesquioxide at high temperature, are described. It was characterized by: crystal structure: fcc, NaCl type; lattice parameter: 5.143 ± 0.001 Å; stoichiometry: O/Eu = 1.021 ± 0.001; and thermodynamics: $\Delta H_{soln} = -87.8 \pm 1.7$ kcal/mole and $\Delta H^0_{Eu_2O_3} = -145.1 \pm 2.2$ kcal/mole. These heats of formation are combined with other thermochemical data to calculate the heat of formation of $Eu^{+2}_{(aq)}$; -114.3 kcal/mole; the $Eu-Eu^{+2}_{(aq)}$ potential: +2.51 volts; and the free energy of disproportionation of EuO: +39.9 kcal. The $S^0_{Eu^{+3}}$ is estimated to be -37.1 e.u. (auth)

13284 (LA-tr-65-1) THERMAL CONDUCTIVITY OF NITROGEN AND HYDROGEN AT TEMPERATURES FROM 20 TO −195°C AND PRESSURES FROM 1 TO 500 ATM. I. F. Golubev and M. V. Kal'sina. Translated by H. Chick (Los Alamos Scientific Lab., N. Mex.), from Gaz. Prom., 9: 41-3(1964). 8p. (Includes original, 3p.). Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mf) JCL.

Calorimetric measurements were made of the thermal conductivity of N_2 and H_2. The excess thermal conductivity vs density graphs were used to calculate thermal conductivity coefficients in the temperature and pressure ranges, and these coefficients are tabulated and shown graphically. (D.L.C.)

13285 (NP-tr-1214) ELECTROCHEMICAL RESEARCH ON RUTHENIUM BY THE METHOD OF RADIOACTIVE TRACERS. I. ANODIC PROCESSES. M. A. El Guebely and M. Haissinsky. Translated by J. M. Jacobs (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from J. Chim. Phys., 51: 290-5(1954). 20p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The anodic oxidation of the sulfate of trivalent ruthenium, 2×10^{-2} M in acid solution, which proceeds as far as RuO_4, takes place in successive stages, passing through valencies IV and VI, and by the formation of an intermediate colloid which is probably an oxide of Ru(V). The appearance of each new state of valency and the rates of formation and disappearance depend on the potential applied at the anode (Au, Pd, or Pt). The same processes take place in the reverse order by reduction on a platinum cathode. Ru(VI) sulfate undergoes disproportionation into Ru(IV) and volatile RuO_4. In the concentration range of radioactive tracers, the formation of an anodic deposit of Ru was observed, characterized by a critical potential the value of which depends on the nature of the electrode Au, Pt, or Pd. This deposit is probably equivalent to the process of formation of the colloidal oxide in more concentrated solution. With increase of the anodic potential, the deposit increases at first and then suddenly decreases. It has been possible to show that the decrease corresponds to the formation of RuO_4 which escapes from the solution and is decomposed on reducing surfaces, giving, in all probability, the oxide of tetravalent ruthenium. (auth)

13286 (SC-T-65-706) ON THE PROBLEM OF THE INFLUENCE OF THE STRUCTURE OF POROUS BODIES ON THE SIZE OF THE SPECIFIC SURFACE AREA BEING DETERMINED BY THE METHOD OF PERMEABILITY OF GASES. B. N. Goshchitskii (Goshchitskiy), I. S. Izrailevich, et al. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex., from Dokl. Akad. Nauk SSSR, 155: 640-3(1964). 9p. Dep.(mn); $1.00(cy) 1(mn) OTS; $1.10(fs), $0.80(mf) JCL.

The specific surface area of a porous medium can be determined using the gas permeability method and the following flow equation: $Q = A(\delta^2\Delta p/\sqrt{\pi\mu RT}(1-\delta)S_0 l) + B(\delta^3 p\Delta p/(1-\delta)^2 S_0^2 l\eta RT)$ mole sec-cm². A discussion is presented of the parameters which characterize the structure in the equation. (D.L.C.)

13287 ON THE DETECTION OF CYANIDE-ION ROTATION IN POTASSIUM CYANIDE BY NEUTRON DIFFRACTION. A. Sequeira (Atomic Energy Establishment, Trombay, India). Acta Cryst., 18: 291-2(Feb. 10, 1965).

The neutron diffraction powder data for potassium cyanide at room temperature were collected. The pattern is shown and observed and calculated structure factors are given. The data seemed to be in slightly better agreement with the static disordered model than the dynamic model for rotation of the cyanide ion. (M.C.G.)

13288 A STUDY ON SOME PNICTIDES AND CHALCOGENIDES. (ANIONS OF GROUPS V AND VI). Argonne Natl. Lab. Rev., 2: No. 1, 14-15(Jan. 1965).

Studies were made of the properties of ThP, UP, PuP, ThS, US, and PuS. Methods of preparation are described, and data on lattice constant, density, and melting point are given. Graphs of absolute Seebeck coefficient vs temperature and resistivity vs temperature are presented for sintered specimens of US, ThS, and US–ThS solid solutions. (M.C.G.)

13289 THE BEHAVIOR OF YTTRIUM, EUROPIUM, AND YTTERBIUM IN MX COMPOUNDS WITH THE METALLOIDS OF GROUPS V AND VI. Giacomo Bruzzone, Assunta Ferro Ruggiero, and Giorgio L. Olcese (Universita, Genoa). Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat., 36: 66-9(Jan. 1964). (In Italian)

The lattice constants, magnetic susceptibility, and the interatomic distance as a function of the radius of the trivalent ions of the rare earth metals were determined. The compounds were prepared by direct interaction of Y, Eu, and Yb and S, Se, Te, P, As, Sb, and Bi. The results obtained are tabulated and shown graphically. (J.S.R.)

13290 ROLE OF HYDROPHOBIC BONDING IN PROTEIN STRUCTURE. Harold A. Scheraga (Cornell Univ.,

Ithaca, N. Y.). Ber. Bunsenges. Physik. Chem., 68: 838-9 (1964).

Discussion is given on a basis for evaluating data from experiments on protein denaturation. A quantitative treatment of hydrophobic bonding is presented based on a theory for the structure of water. Theoretical and experimental sequences prior to investigating the effects of hydrophobic bonding on the stability of proteins are discussed. (P.C.H.)

13291 MAGNETIC PROPERTIES OF URANIUM SULPHIDES. W. Suski and W. Trzebiatowski (Inst. of Structural Research, Polish Academy of Sciences, Wroclaw and Technical Univ., Wroclaw, Poland). Bull. Acad. Polon, Sci., Ser. Sci. Chim., 12: 277-9(1964).

The five compounds existing in the uranium-sulfur system were prepared and their magnetic properties studied. Data indicated that US_3, US_2, and U_3S_5 follow the Curie-Weiss law over the whole temperature range. However, US was ferromagnetic and U_2S_3 exhibited a large deviation from the Curie-Weiss law below 210°K. (M.C.G.)

13292 LOW-TEMPERATURE HEAT CAPACITY OF CERIUM DIHYDRIDE. CRYSTAL FIELD EFFECTS. B. Stalinski and Z. Bieganski (Inst. of Structural Research, Polish Academy of Sciences, Wroclaw). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 331-4(1964).

The thermal capacity of CeH_2 was measured in the temperature range from 20 to 360°K. The sample was prepared by absorption of pure hydrogen by 99.9% pure cerium metal. The thermal capacity of cerium dihydride was much higher than that of yttrium dihydride over the whole temperature range. Data are presented in tables and graphs. (M.C.G.)

13293 NUCLEAR MAGNETIC RESONANCE INVESTIGATIONS OF SOME GROUP V METAL FLUORIDES AND OXYIONS. J. V. Hatton, Y. Saito, and W. G. Schneider (National Research Council, Ottawa). Can. J. Chem., 43: 47-56(Jan. 1965). (NRC-8174)

The nuclear magnetic resonances of ^{51}V, ^{93}Nb, ^{121}Sb, ^{123}Sb, and ^{181}Ta in solutions of the pentafluorides of these elements were measured. All of these nuclei have large electric quadrupole moments. In most cases the chemical species observed was identified by spin-multiplet splitting of the metal resonance. In aqueous 48% HF solutions the ^{181}Ta resonance could not be observed; the ^{121}Sb and ^{123}Sb resonances consist of a symmetrical septet, corresponding to the hexafluoride ion; the ^{93}Nb resonance consists of a single exchange narrowed line; and the ^{51}V resonance consists of a symmetrical quintet, corresponding to the VOF_4^- ion. In alcohol solution NbF_5 disproportionates to form NbF_6^-, whereas in ether and triethylamine solutions, the complexes $NbF_5 \cdot OEt_2$ and $NbF_5 \cdot NEt_3$ are formed. The latter complexes were confirmed by proton resonance measurements. Resonances of ^{51}V in aqueous solutions of V_2O_5 and of NH_4VO_3 as a function of pH show a parallel behavior and reveal the presence of six different oxyions of vanadium. Five of these resonances were assigned to the species, VO_4^{3-}, VO_3^-, $V_2O_7^{4-}$, $V_3O_9^{3-}$, and VO_2^+, on the basis of the resonance line width and the pH range in which the resonance appears. (auth)

13294 SOLVOLYSIS IN LIGHT AND HEAVY WATER. VI. THE ROLE OF INITIAL STATE STRUCTURE. P. M. Laughton and R. E. Robertson (Carleton Univ., Ottawa). Can. J. Chem., 43: 154-8(Jan. 1965). (NRC-8202)

Previous solubility data in light and heavy water are reinterpreted to show that they support primarily the initial state origin for the kinetic solvent isotope effect. Other recent data, including the effect for t-butyl and α-phenethyl fluorides, are also shown to be compatible with the same hypothesis. (auth)

13295 DIFFUSION IN MULTICOMPONENT GASEOUS MIXTURES. PART 2. DIFFUSION OF XENON-133 IN BINARY MIXTURES OF XENON WITH HELIUM, NEON, ARGON, AND KRYPTON. Harry Watts (South Australian Inst. of Tech., Adelaide). Can. J. Chem., 43: 431-5(Feb. 1965).

The diffusion coefficient of trace amounts of xenon-133 was measured in binary mixtures of xenon with helium, neon, argon, and krypton. Measurements were made over the complete composition range in the pressure range 10–300 Torr at 302.6°K. These systems are the first studied in which the results do not agree with the equation: $(1/D_{im}) = \Sigma_{j \neq i}(x_j/\mathcal{D}_{ij})$, which relates the effective diffusion coefficient of a trace in an ideal gas mixture to binary diffusion coefficients and the composition of the mixture. Deviation from this equation can not be accounted for in terms of the known deviation of xenon from ideal gas behavior. The self-diffusion coefficient of xenon was 0.060 and the binary diffusion coefficients Xe–He 0.535, Xe–Ne 0.230, Xe–Ar 0.127, Xe–Kr 0.0823, in $cm^2\ s^{-1}$ corrected to 1 atm pressure. (auth)

13296 ADSORPTION AND CATALYTIC REACTIONS ON EVAPORATED METAL FILMS. X. ADSORPTION AND INTERACTION OF HYDROGEN AND OXYGEN ON MOLYBDENUM. V. Ponec, Z. Knor, and S. Cerny (Inst. of Physics and Chemistry, Prague). Collection Czech. Chem. Commun., 29: 3031-43(Dec. 1964).

The adsorption of hydrogen and oxygen and their interaction were studied on evaporated films of molybdenum. The extent of sorption of the two gases was measured, and changes in film resistance following adsorption and interaction of the two gases were determined. The conditions are specified under which the interaction of both gases takes place on molybdenum films. (auth)

13297 A NEW SERIES OF SELENIC SPINELS OF RARE EARTHS, YTTRIUM, AND SCANDIUM. Micheline Guittard, Charles Souleau, and Hassan Farsam (Faculte de Pharmacie, Paris). Compt. Rend., 259: 2847-9(Oct. 28, 1964). (In French)

Magnesium selenide is combined with selenides of rare earths of the general formula L_2Se_3 and yields the spinels MgL_2Se_4 (L = Ho to Lu). Compounds of the same type are obtained with yttrium and scandium. Manganese selenide MnSe gives spinels only with ytterbium, lutetium, and scandium. All these spinels are normal; the position parameter of the sulfur preserves almost the same value $u = 0.380 \pm 0.003$. (tr-auth)

13298 A NEW FAMILY OF COMPOUNDS OF THE RARE EARTHS ML_2X_4, IN WHICH M EQUALS Sr OR Ba, AND X EQUALS S OR Se, OF ORTHORHOMBIC STRUCTURE. Madeleine Patrie, Sayed Mehdi Golabi, Jean Flahaut, and Louis Domange (Faculte de Pharmacie, Paris). Compt. Rend., 259: 4039-42(Nov. 30, 1964). (In French)

The sulfides SrS and BaS combine with the sulfides of the rare earths to form the compounds ML_2S_4, of the Th_3P_4 cubic type for the first elements of the series and orthorhombic for the succeeding elements. The corresponding selenide derivatives have exactly the same structure. The intensity of the x-ray diffraction beams are equal to those calculated by assuming that the distribution of atoms is the same as in calcium ferrite $CaFe_2O_4$. The rare earth atoms therefore have the coordination number 6 and the alkaline earth metals the coordination number 8. Thirty-two compounds are described. (tr-auth)

13299 KINETICS OF THE REACTION OF STEAM WITH URANIUM MONOCARBIDE AT HIGH TEMPERATURE. Claude Moreau and Joseph Philippot (Centre d'Etudes Nucléaires, Grenoble, France). Compt. Rend., 259: 4285-8(Dec. 9, 1964). (In French)

The reaction of water vapor on massive uranium carbide between 1000 and 1200°C and under a pressure of 23.5 mm Hg led to the appearance of a product formed of different layers. An external layer of UO_2 was built according to a linear mode, and a lower adjacent layer constituted of a mixture of UO_2 and carbon increased according to a parabolic law. The dioxide was stoichiometric in the two cases. The corresponding activation energies were 8 and 55 $kcal \cdot mole^{-1}$, respectively. (tr-auth)

13300 DIELECTRIC MEASUREMENTS ON VACUUM-DEPOSITED THORIUM FLUORIDE FILMS. Saul W. Chaikin and Gilbert A. St. John (Stanford Research Inst., Menlo Park, Calif.). Electrochem. Technol., 2: 356-7(Nov.-Dec. 1964).

The dielectric properties of ThF_4 films were investigated. The metal and dielectric were evaporated in vacua of 10^{-5} to 10^{-6} torr. The ThF_4 deposit was colorless, smooth, amorphous, and adherent. Thorium fluoride capacitors having aluminum electrodes about 700 to 1000 Å thick were fabricated. Dielectric thickness ranged between 1725 and 5800 Å. While no problem with capacitor yield was experienced, a lack of reproducibility of dielectric properties was observed. Dielectric constant varied from 8.8 to 16.4. (M.C.G.)

13301 PREPARATION OF UO_2 POWDER FOR AGGLOMERATE. N. Mizuzava. Genshiryoku Kogyo, 9: No. 4, 10-16(1963). (In Japanese)

The properties needed for UO_2 powder, conditions for obtaining these properties, and methods for obtaining natural and ^{235}U-enriched UO_2 plus their advantages and disadvantages are discussed. Also included is a method being studied for obtaining uranate by adding NH_3 and air (instead of NH_4O_{14}) to a solution of $UO_2(NO_3)_2$. At pH 7 the amount of NH_3 needed to form the uranate is independent of the conditions. A similar method was used to produce enriched UO_2, containing only a trace of F, from UF_6. (TCO)

13302 PRECIPITATION OF URANIUM ALPHA-NITROSO-BETA-NAPHTHOLATE FROM HOMOGENEOUS SOLUTION. S. V. Patil (Karnatak Univ., Dharwar, India). Indian J. Chem., 2: 505-6(Dec. 1964).

A method is described for the quantitative precipitation of uranium as α-nitroso-β-naphtholate from homogeneous solution. The reagent is produced in situ by treating α-naphthol with sodium nitrite in acetic acid medium. After drying the precipitate at 105°C, it is weighed as $UO_2(C_{10}H_6NO_2)_2 \cdot C_{10}H_7NO_2$. Lead, calcium, magnesium, aluminum, and cerium(III) do not interfere in the precipitation of uranium. (auth)

13303 DEPENDENCE OF DIELECTRIC RELAXATION TIME ON FREE-VOLUME AND TEMPERATURE IN HEAVY WATER. M. L. Sisodia and T. L. Dashora (Univ. of Rajasthan, Jaipur, India). Indian J. Pure Appl. Phys., 3: 33-4(Jan. 1965).

It is shown that the temperature dependence of dielectric relaxation time (τ) of heavy water can be adequately expressed by the equation $\tau = A/T \exp[E_\tau/k(T - T_0)]$ in which $A = 9.12 \times 10^{-11}$, $E_\tau/k = 525.8°K$, and $T_0 = 150°K$. The true temperature independent activation energy (E_τ) for dielectric relaxation in heavy water was found to be 1051.6 cal/mole. The dielectric relaxation was used to calculate f, the volume fraction of the free volume, for heavy and light water. It was concluded that the temperature at which free-volume originates may also be the ultimate reference point for liquid relaxation processes. (auth)

13304 MASS SPECTROMETRIC STUDIES OF CHROMIUM, MOLYBDENUM, AND TUNGSTEN HEXACARBONYLS. Robert E. Winters and Robert W. Kiser (Kansas State Univ., Manhattan). Inorg. Chem., 4: 157-61(Feb. 1965).

The appearance potentials of positive ions from chromium hexacarbonyl, molybdenum hexacarbonyl, and tungsten hexacarbonyl were determined. The experimental data were used to derive the heats of formation of various ionic species. The ionization potentials determined for the hexacarbonyls of chromium, molybdenum, and tungsten are 8.15 ± 0.17, 8.23 ± 0.12, and 8.56 ± 0.13 e.v., respectively. Comparisons were made of the energetics of the three compounds in the series and of their fragmentation schemes. From the determined energetic data, second ionization potentials were calculated for a number of $M(CO)_x$ species. (auth)

13305 THE NIOBIUM IODIDES. CHARACTERIZATION OF NIOBIUM(IV) IODIDE, NIOBIUM(III) IODIDE, AND TRINIOBIUM OCTAIODIDE. Pyrtle W. Seabaugh and John D. Corbett (Ames Lab., Ames, Iowa). Inorg. Chem., 4: 176-81(Feb. 1965). (IS-944)

The condensed niobium–niobium(V) iodide system contains three intermediate phases, NbI_4, NbI_3, and Nb_3I_8, all qualitatively diamagnetic at room temperature. Niobium tetraiodide was evidently trimorphic. The weakly endothermic $\alpha \rightarrow \beta$ transition observed at about 348°C only on heating was without effect in the powder pattern data. A more substantial $\beta \rightarrow \gamma$ transition occurred at 417°C, and γ-NbI_4 melted incongruently at 503°C to form an iodide-rich liquid and solid Nb_3I_8. Niobium(III) iodide could be obtained by thermal decomposition of NbI_4, as a sublimate from mixtures with Nb_3I_8, or as the initial product of oxidation of excess metal. The phase was apparently not an equilibrium compound in the system since it decomposed slowly and irreversibly at about 513°C into iodide-rich liquid and Nb_3I_8. The phase in equilibrium with the metal was Nb_3I_8 ($NbI_{2.67 \pm 0.02}$), which could also be obtained by thermal decomposition of higher iodides or as the phase transported from mixtures with metal. The two lower niobium iodides showed only a limited correspondence with those reported in the niobium chloride and bromide and tantalum iodide systems. (auth)

13306 THE PREPARATION AND PROPERTIES OF NIOBIUM TETRAFLUORIDE AND OXYFLUORIDES. F. P. Gortsema and R. Didchenko (Union Carbide Corp., Parma, Ohio). Inorg. Chem., 4: 182-6(Feb. 1965).

Niobium tetrafluoride was prepared by the reduction of niobium pentafluoride with Si or Nb powder at 300 to 350°C. The x-ray diffraction studies of the tetrafluoride showed that it has a tetragonal unit cell with $a_0 = 4.081$ and $c_0 = 8.162$ Å. Reduction of NbF_5 in sealed quartz tubes with red phosphorus, arsenic, or silicon gave rise to a series of very stable niobium oxyfluorides having the same structure as NbF_3. (auth)

13307 COMPLEXES OF THE LANTHANIDE ELEMENTS WITH ALPHA-PICOLINATE AND ALPHA-PICOLINATE N-OXIDE IONS. H. Yoneda, G. R. Choppin, J. L. Bear, and A. J. Graffeo (Florida State Univ., Tallahassee). Inorg. Chem., 4: 244-7(Feb. 1965).

A study was made of the stability constants of α-picolinate complexes of rare earths. The complexes of α-picolinic acid N-oxide were also studied to assess the role of ring size and nitrogen vs oxygen as donor atoms. Data are presented in tables. The variations in the stability constants with increasing atomic number indicated that both of these ligands form chelate complexes with the lanthanide ions. (M.C.G.)

13308 PREPARATION OF $Ba(Na_{0.25}Ta_{0.75})O_3$ AND $Sr(Na_{0.25}Ta_{0.75})O_3$ WITH THE PEROVSKITE STRUCTURE. F. Galasso and J. Pinto (United Aircraft Corp., East Hartford, Conn.). Inorg. Chem., 4: 255(Feb. 1965).

The compounds $Ba(Na_{0.25}Ta_{0.75})O_3$ and $Sr(Na_{0.25}Ta_{0.75})O_3$ were prepared and determined to have a perovskite structure. A comparison was made of observed and calculated intensities in x-ray powder diffraction photographs. (M.C.G.)

13309 THE SCANDIUM TRICHLORIDE-SCANDIUM SYSTEM AND THE QUESTION OF THE EXISTENCE OF SOLID, LOWER CHLORIDES OF SCANDIUM. John D. Corbett and Bob N. Ramsey (Ames Lab., Ames, Iowa). Inorg. Chem., 4: 260-2(Feb. 1965). (IS-1004)

Studies of the $ScCl_3$–Sc system denied the existence of any lower chloride. The salt-rich portion of the equilibrium diagram is shown. The metal exhibited a very substantial solubility in the melt, but no intermediate solid phase was formed. (M.C.G.)

13310 ISOTOPIC EXCHANGE OF O^{18} WITH Co_3O_4. D. Klisurski. Intern. Chem. Eng., 5: 19-22(Jan. 1965).

Isotopic exchange between heavy oxygen of the gaseous phase and oxygen incorporated in Co_3O_4 was investigated at 200, 300, 400, 450, and 480 °C at a pressure of 40 mm Hg. Measurable isotopic exchange was observed at all temperatures; elevation of the temperature strongly increased exchange from part of the surface of the oxide. The rate of isotopic exchange was determined by the bond energy of the oxygen chemisorbed in ionic form from the surface of the oxide. (P.C.H.)

13311 CONDUCTIVITY DISCONTINUITY IN A TWO-PHASE SYSTEM. R. B. Grekila and T. Y. Tien (Westinghouse Electric Corp., Pittsburgh). J. Am. Ceram. Soc., 48: 22-5(Jan. 21, 1965).

A geometric model is presented to describe the electric conductivity in a two-phase system. In the case treated the grains are of equal size and shape and the conductivity changes primarily with changing numbers of contacts between grains of the phase with higher conductivity. A test of the validity of the model was made by application to the two-phase region (from 22 to 50 mole % CaO) of the system ZrO_2–CaO. (auth)

13312 ISOTOPE EXCHANGE RATES. I. THE HOMOGENEOUS REACTION BETWEEN DEUTERIUM AND AMMONIA. Assa Lifshitz, Chava Lifshitz, and S. H. Bauer (Cornell Univ., Ithaca, N. Y.). J. Am. Chem. Soc., 87: 143-50(Jan. 20, 1965).

The thermal isotope exchange reaction between deuterium and ammonia (highly diluted with argon) was investigated behind reflected shocks in a single-pulse shock tube. The temperature range covered was 1300–1700°K. The reaction orders with respect to ammonia and deuterium, as well as the total reaction order, were determined. The exchange rate was found to be approximately unit order with respect to deuterium and argon, and zero order with respect to ammonia. From the known rates of dissociation of D_2 it is evident that the reaction does not proceed via a three-center atomic displacement intermediate. A mechanism based on the vibrational excitation of deuterium molecules by argon as the rate-determining step is proposed. (auth)

13313 THE THERMAL UNIMOLECULAR ISOMERIZATION OF METHYL-d_1 ISOCYANIDE. FALL-OFF AND INVERSE ISOTOPE EFFECT. B. S. Rabinovitch, P. W. Gilderson, and F. W. Schneider (Univ. of Washington, Seattle). J. Am. Chem. Soc., 87: 158-60(Jan. 20, 1965).

Studies were made on methyl-d_1 isocyanide. A brief study was made of the fall-off at 245°C at pressures from 9.3 atm. down to 0.05 mm., and values of k/k_∞ from ~1 down to 0.0042. No significant effect on the fall-off behavior due to the splitting of the four doubly degenerate modes of methyl isocyanide by the deuterium substituent was observed; the variation of fall-off behavior for three compounds, methyl, methyl-d_1, and methyl-d_3 isocyanides, were as expected from differential quantum statistical factors. With decrease of pressure an inverse statistical-weight isotope effect was found that is in good agreement with the theoretical formulation given previously; k_{CH_3}/k_{CH_2D} was measured as 0.75 at the lowest pressure studied and was extrapolated down to ~0.70; the limiting low pressure value was calculated to be $(k_{CH_3}/k_{CH_2D})_0 = 0.67$, on a quantum statistical basis. At the high pressure limit, $k_{CH_3}/k_{CH_2D} \simeq 1$, as expected. (auth)

13314 THE TEMPERATURE DEPENDENCE OF THE SECONDARY DEUTERIUM ISOTOPE EFFECT IN HYDROLYSIS. L. Hakka, A. Queen, and R. E. Robertson (National Council, Ottawa). J. Am. Chem. Soc., 87: 161-3(Jan. 20, 1965).

The secondary deuterium isotope effect for the hydrolysis of t-butyl chloride-d_9 in water and in 50:50 ethanol–water was shown to conform closely to the approximation $\delta_1\Delta F^* = \delta_1\Delta H^*$. This result, while in agreement with accepted hypotheses, contrasts with the temperature dependence of K_H/k_D where there is strong interaction between the alkyl group and the solvent in the quasi–ionic or ionic state. (auth)

13315 RARE GAS ION REACTIONS WITH PENTABORANE-9. G. R. Hertel and W. S. Koski (Johns Hopkins Univ., Baltimore). J. Am. Chem. Soc., 87: 404-8(Feb. 5, 1965).

The reactions between He^+, Ne^+, Ar^+, Kr^+, and Xe^+ ions and pentaborane-9 were studied using a two-stage mass spectrometer in which the ionic products of collisons between positive ions with kinetic energies ranging from 2 to 200 ev and neutral molecules can be detected. The fragmentation of the pentaborane varied markedly as a function of the recombination energy of the rare gas ion. With xenon ions, only $B_5H_7^+$ and $B_5H_5^+$ were produced in significant amounts, while helium ion bombardment resulted in a variety of $B_5H_n^+$, $B_4H_n^+$, and $B_3H_n^+$ ions. The kinetic energy of the bombarding ion in many cases had a significant effect on the relative abundances of the products. By plotting the relative abundances of the products as a function of the excitation energy of the rare gas ions, breakdown curves for pentaborane-9 were constructed. The mass spectrum obtained by integrating the breakdown curves was in reasonably good agreement with the 70-v electron impact spectrum. The possible role of the pentaborane-9 fragment ions in the proposed mechanism of the rare gas sensitized radiolysis is discussed. (auth)

13316 CONVENIENT DEUTERIUM LABELING FOR MASS SPECTROMETRY VIA EXCHANGE OF ENOLIZABLE HYDROGEN ON A GAS-LIQUID CHROMATOGRAPHY COLUMN. Martin Senn, Wilhelm J. Richter, and A. L. Burlingame (Univ. of California, Berkeley). J. Am. Chem. Soc., 87: 680-1(Feb. 5, 1965).

The quantitative exchange of enolizable hydrogen atoms in ketones is reported. It was effected during a single pass through a gas-liquid chromatography column pretreated with deuterium. Over 50 compounds of various structural types containing exchangeable hydrogen were examined. The compounds showed a deuterium uptake on the average of about 96%. (M.C.G.)

13317 VAPOR PRESSURE OF HAFNIUM (IV) IODIDE. F. D. Stevenson and C. E. Wicks (Oregon State Univ., Corvallis and Bureau of Mines, Albany, Ore.). J. Chem. Eng. Data, 10: 33-6(Jan. 1965). (IS-1065(Rev.))

Vapor pressures of the hafnium(IV) iodide system were measured between 263 and 406°C by a metal diaphragm technique. Three stable forms of the HfI_4 were identified (α, β, and γ modifications), in addition to a metastable form that transforms slowly at temperatures in the vicinity of 300°C to the α-modification. Enthalpies of sublimation, ΔH_T°, were found to be 28.37 ± 0.04 (263 to 401°C), 48.9 ± 1.3 (302 to 324°C), 33.7 ± 0.6 (325 to 372°C), and 28.2 ± 0.5 (375 to 405°C) kcal/gram mole for the mestastable, α, β, and γ modifications, respectively. The transition temperatures were measured by thermal analysis to be 329 ± 3°C and 375 ± 2°C for the $(\alpha-\beta)$ and $(\beta-\gamma)$ transitions, respectively. (auth)

13318 ON THE DIFFERENCE BETWEEN THE THERMODYNAMIC BEHAVIOR OF ARGON IN D_2O AND H_2O. A. Ben-Naim (Hebrew Univ., Jerusalem). J. Chem. Phys., 42: 1512-14(Mar. 1, 1965).

The solubility of argon was measured in D_2O (99.7%) at five temperatures: 5, 10, 15, 20, and 25°C. The standard entropies, enthalpies, and free energies of solution were calculated, and compared with the corresponding values in H_2O. The differences in the thermodynamic functions of solution in D_2O and in H_2O are interpreted in terms of the two-structure model for liquid water, and are attributed to the difference in the degree of crystallinity of the two solvents. (auth)

13319 MOLECULAR COLLISION CROSS SECTION DUE TO QUADRUPOLE-INDUCED DIPOLE AND DIPOLE-INDUCED QUADRUPOLE INTERACTIONS. Krishnaji and Shyam Lal Srivastava (Univ. of Allahabad, India). J. Chem. Phys., 42: 1546-8(Mar. 1, 1965).

A theory for molecular collision cross section due to quadrupole-induced dipole and dipole-induced quadrupole interactions was developed following the Anderson–Tsao–Curnutte approach. The OCS–He, OCS–Ar, and HCl–Ar collisions are discussed. For HCl–Ar collisions, $\mu_1 q_1 \alpha_2$ interactions were found to be important, whereas in OCS–He and OCS–Ar collisions these were negligibly small. (auth)

13320 RADIO-FREQUENCY AND MICROWAVE SPECTRA OF $^6Li^{127}I$ BY THE MOLECULAR-BEAM ELECTRIC-RESONANCE METHOD. F. W. Breivogel, Jr., A. J.

Hebert, and K. Street, Jr. (Univ. of California, Berkeley). J. Chem. Phys., 42: 1555-8(Mar. 1, 1965). (UCRL-11404)

The radiofrequency and microwave spectra of $^6Li^{127}I$ were observed by the molecular-beam electric-resonance method of molecular spectroscopy. Spectra of $^6Li^{127}I$ in the first two vibrational states were obtained. From the J = 1 radio-frequency, Stark spectra values were obtained for the electric dipole moment μ, the iodine nuclear quadrupole interaction eqQ_1, and the iodine spin-rotation constant c_1. The observation of J = 1 → J = 0 microwave transitions yielded the following rotational constants: $B_0 = 15,304.895 \pm 0.005$ Mc/sec and $B_1 = 15,153.316 \pm 0.009$ Mc/sec. (auth)

13321 LUMINESCENCE AND ENERGY TRANSFER IN SOLUTIONS OF RARE-EARTH COMPLEXES. I. ENHANCEMENT OF FLUORESCENCE BY DEUTERIUM SUBSTITUTION. John L. Kropp and Maurice W. Windsor (TRW/Space Tech. Labs., Inc., Redondo Beach, Calif.). J. Chem. Phys., 42: 1599-1608(Mar. 1, 1965).

Fluorescence yields and lifetimes of solutions of europium and terbium salts in solution were greatly enhanced by using deuterated solvents. The magnitude of increase varied from an 18-fold enhancement in yield and lifetime for an aqueous solution of europium nitrate to a twofold enhancement for europium ethylenediaminetetra-acetate disolved in methanol. The enhancement was proportional to the fraction of deuterated solvent present. Results led to conclusions that the dominant mode of radiationless deactivation of a rare earth ion in solution is via loss of energy to hydrogen vibrations. Further, such loss was concluded to be proportional to the number of hydrogen vibrations in the local rare earth environment. Values for the rate constant for radiationless loss of energy to hydrogen vibrations were determined for the salts studied. The influence upon radiationless processes of complexing between the rare earth and anion is discussed. The dependence of the enhancement factor on the rare earth ion is also considered. There is no evidence that the lifetime from the $^5D_1$ level of europium nitrate is enhanced by deuterium substitution. This lifetime is ≤ 5 μsec in both D_2O and H_2O solutions. (auth)

13322 SECONDARY ISOTOPE EFFECTS ON AMPLITUDES OF MOLECULAR VIBRATIONS. L. S. Bartell (Iowa State Univ., Ames). J. Chem. Phys., 42: 1681-7(Mar. 1, 1965).

Secondary isotope effects on amplitudes of bond oscillations in harmonically vibrating polyatomic molecules were studied using normal coordinate theory. Morino's scheme for circumventing the L matrix by expanding the normal coordinate mean-square amplitude matrix in integral powers of the Λ matrix was extended and found to lead to some simple inequalities. Upper and lower limits of bond amplitudes were established, which were rigorously independent of masses of atoms other than the atoms in the bond. It is shown that the upper limit of secondary mass dependency vanishes with increasing temperature much more rapidly than does the primary mass dependency. Even at absolute zero, secondary isotope effects on bond amplitudes were found to be relatively very much smaller than secondary isotope effects on bond frequencies. Numerical results of "exact" and various approximate approaches for calculating root-mean-square amplitudes are presented for the C−I bonds in CH_3I and CD_3I and for the C = C bonds in C_2H_4 and C_2D_4. The smallness of secondary isotope effects on amplitudes indicated that their coupling with Morse bond asymmetry is not a major source of some recently reported secondary isotope effects on bond lengths. (auth)

13323 ON THE IMPORTANCE OF THE POLARIZATION ENERGY IN INELASTIC ION-MOLECULE COLLISIONS. Hyung Kyu Shin (Cornell Univ., Ithaca, N. Y.). J. Chem. Phys., 42: 1739-43(Mar. 1, 1965).

By evaluating the vibrational transition probability for the collision between an ion and molecule, the importance of the polarization energy due to the static charge on the ion and the dipole moment induced on molecule is discussed. The final expression for the de-excitation probability per unit time showed that the polarization energy plays a leading role in bringing two particles closer so that the resulting interaction may become a hard, "close-in" collision and that the inclusion of this attractive energy significantly increases the efficiency of the vibrational energy transfer. (auth)

13324 DISSOCIATIVE IONIZATION OF MOLECULES BY RARE-GAS ION IMPACT. William B. Maier, II. (Univ. of Chicago). J. Chem. Phys., 42: 1790-1804(Mar. 1, 1965).

Reactions of rare gas ions with N_2O, C_2H_2, C_2H_4, and D_2 were studied. Cross sections are given for primary-ion energies below 120 ev. These cross sections were compared for qualitative differences. Most of the reactions had rather sharp onsets, and a semiempirical formula was fitted to the data near the apparent threshold energy. The results of this investigation showed that useful information about bond energies can be obtained from ion-molecule reactions. The data are consistent with $D(H_2C = CH_2) = 8.11 + 0.10 - 0.18$ ev and thus with $D(CH-H) = 3.99 + 0.05 - 0.09$ ev, although smaller values of $D(H_2C = CH_2)$, and thus larger values of D(CH−H), could not be entirely excluded. The results indicated that ion-impact methods may possess inherent advantages over electron-impact methods in certain cases; for example, the data showed that the electron-impact appearance potential of $C_2H_3^+$ from C_2H_4 is certainly 0.3 ev and probably 0.6 ev larger than the true threshold energy. The threshold behavior of an endothermic charge-transfer process $Kr^+ + D_2 \rightarrow D_2^+ + Kr$ was studied, and the cross section for this reaction was comparable in size to many of the other endothermic reactions observed, despite the fact that kinetic energy of the colliding particles must be converted into electronic energy for the reaction to proceed. (auth)

13325 INTERMOLECULAR NUCLEAR OVERHAUSER EFFECT IN LIQUID SOLUTIONS. Reinhold Kaiser (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 42: 1838-9(Mar. 1, 1965).

The Overhauser effect was studied in a mixture of chloroform, cyclohexane, and tetramethylsilane added for operation of a field-frequency stabilizer of the high-resolution spectrometer. The spectrum showed three sharp lines, one for each component. The cyclohexane resonance could be irradiated at a fixed frequency, and the chloroform resonance could simultaneously be observed by sweeping a second frequency using magnetic-field modulation and lock-in detection at audio frequencies. Scanning back and forth through the chloroform resonance with a very weak observing field showed an increase in peak height of 31% when the cyclohexane resonance was saturated. The increase established itself with a time constant of the order of 30 sec after the irradiation frequency was set to the cyclohexane resonance. The initial height of the u-mode signal after rapid adiabatic passage into the chloroform resonance center increased by 37% when the cyclohexane resonance was saturated. The chloroform transverse relaxation time was 7.2 sec, and the spin-lattice relaxation time was 25 sec. The maximum relative enhancement that can be produced by the Overhauser effect through the intermolecular dipole coupling is ½, and the observed increase of only 34% indicated competing mechanisms for relaxation of the chloroform proton. (M.C.G.)

13326 ORIGIN OF THE MOLECULAR PHOSPHORESCENCE IN SOME EUROPIUM CHELATE SOLUTIONS. M. L. Bhaumik (Electro-Optical Systems, Inc., Pasadena, Calif.), L. Ferder, and M. A. El-Sayed. J. Chem. Phys., 42: 1843-4(Mar. 1, 1965).

An investigation was made of the origin of molecular phosphorescence in europium benzoyltrifluoracetonate. Results indicated that the phosphorescence has a different origin from that of the intramolecularly sensitized ion emission. It was found that relatively weak, long-lived phosphorescence arises whether or not the chelate gives rise to ion emission by transfer of energy. It was also indicated that the phosphorescence is due to a dissociation product, which is most probably a ligand negative ion. (M.C.G.)

13327 EVIDENCE FOR A TRIVALENT EUROPIUM COMPLEX WITH D_{4d} SYMMETRY. N. J. Rose and E. Abramson (E. I. du Pont de Nemours & Co., Wilmington, Del.). J. Chem. Phys., 42: 1849-50(Mar. 1, 1965).

The hexafluorophosphate salt of octakis (4-picoline-N-oxide) europium(III) was isolated and its fluorescence emission spectrum measured at ~ 77°K. Analysis of the spectral data indicated that the europium ion is in a site with D_{4d} symmetry; thus the complex appeared to have the square antiprism structure. A correlation of transition and wavelength is presented. (M.C.G.)

13328 SOME OXYCHLORO-COMPLEXES OF QUINQUEVALENT ELEMENTS. D. Brown (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc.: 4944-8(Dec. 1964)

X-ray diffraction, magnetic, susceptibility, and infrared studies are reported for cesium oxychloro-complexes of the type $Cs_2M(V)OCl_5$ (M(V) = Nb, Cr, Mo, and W). (auth)

13329 WATER IN HYDRATES. PART I. FRACTIONATION OF HYDROGEN ISOTOPES BY CRYSTALLISATION OF SALT HYDRATES. R. M. Barrer and A. F. Denny (Imperial Coll. of Science and Tech., London). J. Chem. Soc.: 4677-84(Dec. 1964).

Isotopic fractionation of mixtures of light and heavy water during the crystallization of stoichiometric crystallohydrates from their saturated solutions was studied. The crystallizing salt hydrates gave separation factors in the probable order, $BeSO_4 \simeq CuCl_2 > KAl(SO_4)_2 \simeq Al_2(SO_4)_3 > SrCl_2 \simeq CuSO_4$. In all cases crystallization caused the mother-liquor to be enriched in heavy water. The possible significance and interpretation of the results are considered. (auth)

13330 WATER IN HYDRATES. PART II. LIGHT AND HEAVY WATER AND SULPHUR DIOXIDE IN SYNTHETIC ZEOLITES. R. M. Barrer and A. F. Denny (Imperial Coll. of Science and Tech., London). J. Chem. Soc.: 4684-92 (Dec. 1964).

The sorption of light and heavy water and of sulfur dioxide by a number of synthetic zeolites was studied. Sorption of water was reversible in zeolites Na-X and Na-A; it was irreversible in Na-A, Ca-A, Na-Y, and basic sodalite, revealing hysteresis effects of considerable complexity. Sorption of sulfur dioxide was reversible on the X, Y, and A zeolites, but on basic sodalite sorption was very slow and also a side reaction yielded some sulfur on outgassing. When reversible sorption of water occurred it was found that the differences in sorption of liquid D_2O and H_2O in Na-X and Na-A were negligible; but that small differences existed for uptake of the vapors. This is in line with results previously observed for chabazite, gmelinite, and heulandite. (auth)

13331 THE ADSORPTION OF CATIONS AT THE SILVER IODIDE-SOLUTION INTERFACE. PART I. LANTHANUM AND NEODYMIUM. M. B. Abramson, M. J. Jaycock, and R. H. Ottewill (Cambridge Univ., Eng.). J. Chem. Soc.: 5034-40(Dec. 1964).

The adsorption of lanthanum and neodymium cations on powdered silver iodide was measured, by use of a radiotracer method, at a constant concentration of the potential-determining iodide ion, as a function of pH. In all cases, plots of log moles of cation adsorbed against log moles of the equilibrium concentration of cation were linear at the lower concentrations. The adsorption behavior of neodymium was virtually independent of pH in the region 1.9–6.0. In the case of lanthanum the adsorption appeared to be independent of pH in the region 2.0–5.0, but there was a marked increase above 6.5, which was ascribed to the increased adsorption of the hydrolyzed lanthanum ion. (auth)

13332 THE ADSORPTION OF CATIONS AT THE SILVER IODIDE-SOLUTION INTERFACE. PART II. THORIUM. M. B. Abramson, M. J. Jaycock, and R. H. Ottewill (Cambridge Univ., Eng.). J. Chem. Soc.: 5041-5(Dec. 1964).

The adsorption of thorium on silver iodide powder was measured as a function of pH, by use of ^{234}Th as a tracer. The isotherms appear to be of the Freundlich type. The extent of adsorption increased with pH, gradually between 2.0 and 4.2, and very rapidly above 4.2. The results indicate that simple hydrolysis products may be the adsorbing species below pH 4.2, but above this adsorption of multinuclear complexes occurs. The conclusions are supported by electrokinetic measurements. (auth)

13333 NEW LOWER IODIDES OF THORIUM. D. E. Scaife and A. W. Wylie (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Chem. Soc.: 5450-8(Dec. 1964).

Three lower iodides of thorium were characterized, viz., thorium tri-iodide, α-thorium di-iodide, and β (high temperature) thorium di-iodide. As the temperature is raised these iodides, undergo peritectic transformation as follows: thorium tri-iodide into β-thorium di-iodide at 746°C, and β-thorium di-iodide into thorium metal at 864°C. Solid state transition of α-di-iodide into the β modification occurs sluggishly at 600–700°C. These relationships are summarized in the form of an equilibrium diagram for the system thorium-iodine. Evidence for a fourth iodide of thorium at I/Th 3.3–3.4 is discussed but its existence is doubted. Distinct x-ray diffraction patterns were obtained for all lower iodides. That for β-thorium di-iodide was indexed on the basis of a hexagonal unit cell with $a_0 = 9.21$ Å, $c_0 = 3.74$ Å. That for α-thorium di-iodide can be indexed on the basis of a hexagonal unit cell with $a_0 = 8.00$ Å, $c_0 = 7.87$ Å. The diffraction pattern for thorium tri-iodide is complex and does not resemble that of expected structure types. Microscopical observation shows that β-thorium di-iodide is opaque, and golden with metallic reflection. Thorium tri-iodide is black, faintly translucent, and shows a strong blue-green dichroism and probably contains the ion Th^{3+}. Both these two iodides and α-thorium di-iodide, which is difficult to characterize microscopically, are vigorously decomposed by water without formation of solid residues or colored solutions. (auth)

13334 THE SOLUTION CHEMISTRY AND CHROMATOGRAPHIC BEHAVIOUR OF TECHNETIUM IN AQUEOUS HCl AND HBr. L. Ossicini, F. Saracino, and M. Lederer (Consiglio Nazionale delle Ricerche, Rome). J. Chromatog., 16: 524-37(Dec. 1964).

The solution chemistry of Tc was studied in HCl and HBr employing paper chromatography and ion exchange paper chromatography. Techniques for the identification of TcO_4^-, Tc(V), and various Tc(IV) species were worked out. Among the properties of Tc that were not well defined previously was a rather unexpectedly high stability of Tc(V) in HCl solutions and the slow reaction between Tc(VII) and Tc(IV) in dilute HCl solution as well as the coexistence of three different valencies in various concentrations of HCl and HBr. The hydrolysis of hexahalotechnetates(IV) revealed a number of either neutral or cationic species. (P.C.H.)

13335 POLAROGRAPHY AND ZONE ELECTROPHORESIS OF URANYL-BETA-ALANINE COMPLEXES. Tsai-Teh Lai and Han-Ton Lin (Cheng Kung Univ., Tainan, Taiwan, China. J. Inorg. Nucl. Chem., 27: 173-8(Jan. 1965).

The uranyl-β-alanine complex was studied by polarography and zone electrophoresis over the pH range from 0.7 to 5.4 and the ligand concentration range from 0.203 to 0.812M. The concentration of dipolar β-alanine ion for complex formation with uranyl ion at minimum pH value was calculated to be 4.5 times the metal concentration. The concentration of hydroxyl ion for the complex beginning to attach to the hydroxyl ligand was a linear function of the concentration of dipolar β-alanine ion. The complex species and electrode reactions are given. (auth)

13336 THE THIRD PHASE IN AMINE SYSTEMS. J. M. P. J. Verstegen (Institutt for Atomenergi, Kjeller, Norway). J. Inorg. Nucl. Chem., 27: 201-7(Jan. 1965).

Numerical data are given on organic phases, which are formed by dissolution of $UO_2(NO_3)_2$ hydrates in solutions

of 0.1M (TOAH)NO_3 in dodecane, modified with 4 to 15 vol % n-octanol. The role of the modifier is discussed, and it was concluded that the long-chain alcohol forms hydrogen bonds with (TOAH)NO_3. A relationship between n-octanol concentration and U solubility is given. (auth)

13337 THE THERMAL DECOMPOSITION OF THE COMPLEX FORMED IN THE URANIUM(VI)-NITRIC ACID-TRI-N-DODECYLAMINE EXTRACTION SYSTEM. Taichi Sato (Government Chemical Industrial Research Inst., Tokyo). J. Inorg. Nucl. Chem., 27: 240-3(Jan. 1965).

Studies were made of thermal decomposition of the complex formed in the uranium(VI)–nitric acid–tridodecylamine (TDA) system. Thermogravimetric and differential analysis curves are presented. The nitro complex was found to be less stable than the corresponding sulfato complex. (M.C.G.)

13338 EXCHANGE OF RARE-EARTH IONS IN CHELATE SOLUTIONS. M. L. Bhaumik (Electro-Optical Systems, Inc., Pasadena, Calif.). J. Inorg. Nucl. Chem. 27: 243-4(Jan. 1965).

Studies were made of the fluorescence of solutions of rare earth chelates. The formation of chelates with a new ion by the exchange process could be detected by observing the characteristic ion fluorescence. Studies of europium exchange with terbium in chelates and the resulting changes in fluorescence are described. (M.C.G.)

13339 CRYSTALLOGRAPHIC DATA ON DIMETHYL SULPHOXIDE COMPLEXES OF ZIRCONYL AND THORIUM PERCHLORATES. V. Krishnan and C. C. Patel (Indian Inst. of Science, Bangalore). J. Inorg. Nucl. Chem., 27: 244-7(Jan. 1965).

Dimethyl sulfoxide complexes of zirconyl perchlorate and of thorium perchlorate were prepared. Microscopic examination of the complexes under a polarizing microscope showed prismatic habit of the crystals. The x-ray diffraction patterns were taken, and the data obtained are presented in tables. (M.C.G.)

13340 EUROPIUM THENOYLTRIFLUOROACETONATE, PREPARATION AND FLUORESCENCE PROPERTIES. R. G. Charles and R. C. Ohlmann (Westinghouse Electric Corp., Pittsburgh). J. Inorg. Nucl. Chem., 27: 255-9(Jan. 1965).

A method is described for preparing the dihydrate of europium thenoyltrifluoroacetone. Fluorescent properties of the compound are reported and compared with those of other europium diketone chelates. A thermogravimetric curve, ultraviolet absorption spectra, and fluorescence spectra are shown. (M.C.G.)

13341 RARE-EARTH CHELATE VAPOUR. M. L. Bhaumik (Electro-Optical Systems, Pasadena, Calif.). J. Inorg. Nucl. Chem., 27: 261(Jan. 1965).

Preparation and thermal stability of europium hexafluoroacetylacetonate are described. On heating the complex at 120°C under vacuum, it was observed that the sublimate shows a europium fluorescence as strong as the starting material. Therefore, it was concluded that the chelate passed through the vapor phase without decomposition. (M.C.G.)

13342 URANIUM(IV) CARBOXYLATES. Ram Chand Paul, J. S. Ghotra, and M. S. Bains (Panjab Univ., India). J. Inorg. Nucl. Chem., 27: 265-6(Jan. 1965).

It was found that if a solution of uranyl acetate in acetic acid with a minimum quantity of water (or of uranyl chloride in anhydrous glacial acetic acid) is refluxed or warmed with zinc amalgam it is reduced to uranium(IV) and pure zinc hexaacetate uranium(IV) is produced. This compound was converted to uranium tetraacetate by adding hydrochloric acid in acetic acid solution. On refluxing pure uranium(IV) acetate is precipitated. (The product from uranyl chloride was warmed with acetic anhydride to prepare uranium tetraacetate.) Higher carboxylates of uranium(IV) were prepared by the acid interchange method in which the acetate was treated with an excess of a higher fatty acid. (M.C.G.)

13343 CALCULATION OF INERTIA DEFECT. PART IV. ETHYLENE-TYPE MOLECULES. Kozo Kuchitsu, Takeshi Oka, and Yonezo Morino (Tokyo Univ.). J. Mol. Spectry., 15: 51-67(Jan. 1965).

The inertia defects of some ethylene-type molecules. C_2X_4, (X = H, D, F, Cl, and Br), were calculated on the basis of the general formulation developed previously. The L^{-1} matrices, the Coriolis coupling constants, and the contributions to the inertia defect from individual vibrational modes were evaluated by using the force constants and the fundamental frequencies taken from the literature. For C_2H_4 and C_2D_4, they were also calculated by using the approximate normal frequencies, which were estimated from an empirical observation that the anharmonic corrections for a number of simple hydrides and deuterides are systematic. The results were compared with those derived from the fundamental frequencies in order to estimate the uncertainty of the calculated values. The inertia defects for the ground vibrational state, Δ_0, thus obtained were 0.050 (C_2H_4), 0.070 (C_2D_4), 0.15$_2$ (C_2F_4), 0.25$_2$ (C_2Cl_4), and 0.41$_3$ (C_2Br_4) in amu A^2 units. They were found to be nearly equal to those of the corresponding X_2CO molecules; the Δ_0 values of C_2F_4 and C_2Cl_4 were also found to be close to the observed values of the corresponding vinylidene and cis-$C_2H_2X_2$ molecules. These facts are explained by considering the effects of in-plane and out-of-plane vibrations of a planar molecule on Δ_0; it is demonstrated in general that the Coriolis interactions between the out-of-plane and in-plane vibrations make definitely negative contributions to Δ_0, which nearly compensate the positive contributions from the interactions among the in-plane vibrations. (auth)

13344 A PERTURBATION METHOD SUITABLE FOR HIGHER ORDER CALCULATIONS. James D. Louck (Los Alamos Scientific Lab., N. Mex.). J. Mol. Spectry., 15: 68-82(Jan. 1965). (LADC-6329)

A form of perturbation theory is described, which is useful for calculation of higher order corrections. In technique of application, the method is intermediate to the usual Rayleigh-Schrödinger method and the contact transformation technique of Van Vleck, but it appeared to be more appropriate than either for a number of problems. (auth)

13345 EIGENVECTORS OF A SLIGHTLY ASYMMETRIC ROTATOR. James D. Louck (Los Alamos Scientific Lab., N. Mex.). J. Mol. Spectry., 15: 83-99(Jan. 1965). (LADC-6330)

The normalized eigenvectors of a slightly asymmetric rotator were obtained through fourth order in the asymmetry parameter. The perturbation method was previously described. The commutator relations, which were developed in connection with the asymmetric rotator should be useful for calculating corrections to energy eigenvalues, which arise from higher order angular momentum terms in the vibration-rotation Hamiltonian for a molecule. (auth)

13346 THE HEAT OF SUBLIMATION OF URANIUM AND THE CONSISTENCY OF THE THERMODYNAMIC DATA FOR URANIUM COMPOUNDS. J. Drowart, A. Pattoret, and S. Smoes (Universite Libre, Brussels). J. Nucl. Mater., 12: 319-22(1964).

A review of thermochemical data for vaporization of the oxides and carbides of uranium was made to derive indirect values for the heat of sublimation of uranium from the corresponding thermodynamic cycles. The values obtained were in good agreement with the direct value determined by mass-spectrometry, $\Delta H^0_{298.2}(U) = 125.5 \pm 2.5$ kcal/g atom and with the value $\Delta H^0_{298.15}(U) = 126 \pm 5$ kcal/g atom also determined by mass spectrometry by De Maria, Burns, Drowart, and Inghram (J. Chem. Phys. 32: 1373 (1960)). (auth)

13347 THE VOLATILITY OF PLUTONIUM CARBIDES. P. E. Potter (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 12: 345-8(1964). (AERE-M-1356)

On heating Pu-C systems close to the PuC composition, considerable decomposition occurred at 1550 °C. Plutonium vaporized and the remaining carbon reacted with the mono-

carbide to form Pu_2C_3. The diffusion of Pu through a layer of Pu_2C_3 was a probable rate-determining step for the vaporization of Pu. (auth)

13348 VISIBLE AND NEAR-INFRARED ABSORPTION OF URANIUM IN SODIUM–SILICATE GLASS. M. A. Carrell and D. R. Wilder (Ames Lab., Ames, Iowa). J. Nucl. Mater., 13: 142-51(1964). (IS-771)

The visible and near-infrared absorption spectra were observed for glass-forming compositions in the sodium silicate-uranium system. Correlation of the observed spectra with the prevailing uranium ion indicated U(IV) was present when the glass was formed under reducing conditions but not for oxidizing conditions. U(V) was indicated under both oxidizing and reducing conditions. U(VI) was found associated with the UO_2^{++} group and with high sodium contents. (auth)

13349 THE INFLUENCE OF ALLOYING ELEMENTS OF THE TERMINAL SOLUBILITY OF HYDROGEN IN α-ZIRCONIUM. W. H. Erickson (Atomic Energy of Canada Ltd., Chalk River, Ont.) and D. Hardie. J. Nucl. Mater., 13: 254-62(1964).

The terminal solubility of hydrogen in the α-phase of binary alloys of zirconium with niobium, titanium, hafnium, yttrium, indium, lead, antimony, and oxygen was examined by means of hydrogen pressure-concentration isotherms above the eutectoid temperature and a dilatometric technique below. The solubility above the eutectoid temperature was found to be increased by the presence of β-stabilizing elements and decreased by α-stabilizers. Below the eutectoid temperature however, alloying additions, even when present in considerable quantity in solid solution, did not have any significant effect on the terminal solubility of hydrogen in α-zirconium, which can be represented by the equation C_T (ppm) = $4.4 \times 10^5 \exp(-10660/RT)$. (auth)

13350 AN EXPERIMENT TO CLARIFY THE EFFECT OF DISSOLVED OXYGEN ON THE TERMINAL SOLUBILITY OF HYDROGEN IN ZIRCONIUM. C. Roy (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 13: 275-7(1964).

By autoradiography the distribution of tritium in the oxygen-rich zone beneath the oxide after oxidation of zirconium was followed. It was concluded that during oxidation of zirconium in oxygen at 500°C the solution of oxygen in zirconium displaces hydrogen previously present in the region. At high temperature (800°C), hydrogen migrated out of the metal zone enriched even to a small extent in oxygen. It was also indicated that at some temperature between 500 and 800°C the hydrogen solubility is increased by slight enrichments of the zirconium in oxygen. (M.C.G.)

13351 A NOTE ON THE REDUCTION OF U_3O_8 TO UO_2. R. Sato (Mitsubishi Mining and Metallurgical Co., Ltd., Omiya City, Japan), H. Doi, and H. Uchikoshi. J. Nucl. Mater., 15: 146-8(1965).

Reduction of U_3O_8 to UO_2 was carried out. Ammonium diuranate was calcined in air at 700°C for 3 hr to prepare the U_3O_8 starting material. The result of differential thermal analysis in hydrogen of the U_3O_8 is shown. That the samples before and after the thermal analysis were respectively U_3O_8 and UO_2 was confirmed by x-ray diffraction as well as by gravimetric analysis. It was found that the heat evolution accompanying the reduction of U_3O_8 to UO_2 in hydrogen consists of three exothermic peaks. It is shown that U_3O_8 is first reduced to U_3O_{8-x}. (M.C.G.)

13352 ENTHALPY OF URANIUM DIOXIDE TO 2350°C. J. B. Conway and R. A. Hein (General Electric Co., Cincinnati). J. Nucl. Mater., 15: 149-50(1965).

Enthalpy data from 900 to 2350°C are presented for UO_2. Reactor-grade UO_2 powder of 99.9% purity was cold pressed at 20,000 psi and then sintered for 2 hr in hydrogen at 1700°C to yield a compact with 97.0% theoretical density. The samples were placed in molybdenum capsules and heated. After thermal equilibrium was established, the capsule was allowed to fall into a closed-end drop tube in a modified adiabatic water calorimeter. The observed increase in water temperature was used to calculate total heat release. Data are presented in graph form. (M.C.G.)

13353 DESCRIPTION AND ANALYSIS OF THE THIRD SPECTRUM OF CERIUM (Ce III). Jack Sugar (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Am., 55: 33-58(Jan. 1965).

Observations of the third spectrum of cerium from 757 to 11,091 Å are given, including 1,700 lines not previously reported. The ground level of the ion was established as the $^3H_4$ state of the $4f^2$ electronic configuration. One hundred and twenty-six newly discovered energy levels are given, together with revised values of previously known levels. The ionization limit, at 161,955 cm^{-1}, was derived from the three member $4f$ nd series. (auth)

13354 ENERGY LEVELS OF THE FIRST SPECTRUM OF EUROPIUM (Eu I). G. Smith and B. G. Wybourne (Argonne National Lab., Ill.). J. Opt. Soc. Am., 55: 121-5 (Feb. 1965).

A theoretical analysis of the Eu(I) spectrum was attempted with the use of available experimental data. Energy matrices including both electrostatic and spin–orbit interactions were constructed and, wherever possible, Slater parameters giving a best fit to the observed levels were derived. The positions reported for terms below about 40,000 cm^{-1} arising from the addition of two electrons to the $^8S_{7/2}$ ground state of the $4f^7$ core are critically examined. The analysis confirmed the identifications previously given to terms below 32,000 cm^{-1} but revealed a number of discrepancies in the assignments of levels to higher terms. Tables of observed and computed wavenumbers, eigenvectors, and theoretical g_J values are presented for the configurations $4f^7(^8S)6s6p$, $4f^7(^8S)6s5d$, and $4f^7(^8S)5d6p$. The configurations $4f^7(^8S)6s7s$, $4f^7(^8S)6s8s$, $4f^7(^8S)6s7p$, $4f^7(^8S)6s5f$, $4f^7(^8S)5d^2$, and $4f^7(^8S)6s6d$ are also discussed, together with the likely influence of configuration interaction. (auth)

13355 CONFIGURATION INTERACTION IN THE $4f^3$ CONFIGURATION OF Pr III. K. Rajnak (Univ. of California, Berkeley). J. Opt. Soc. Am., 55: 126-32(Feb. 1965). (UCRL-11523)

The energies of 37 observed levels of the $4f^3$ configuration of Pr(III) were calculated with an rms deviation of ±29 cm^{-1} by use of 13 adjustable parameters, including 5 parameters that account for nonlinear configuration-interaction effects. The physical significance of the nonlinear parameters is discussed in terms of the relative roles of various mechanisms of configuration interaction. (auth)

13356 THE WIEN EFFECT IN URANYL ION SOLUTIONS. I. URANYL NITRATE AND PERCHLORATE FROM 5 TO 65°. NEGATIVE WIEN EFFECTS. Joseph F. Spinnler and Andrew Patterson, Jr. (Yale Univ., New Haven). J. Phys. Chem., 69: 500-8(Feb. 1965). (TID-21321)

Experimental data on aqueous solutions of uranyl nitrate and uranyl perchlorate are presented for the temperatures 5, 15, 25, 50, and 65°C. Plots of the pH vs log of concentration, of the equivalent conductance vs square root of concentration, and of the high-field conductance as a function of field are presented. The range of concentration studied lies between 10^{-5} and 10^{-3}M. The high-field conductance results were unprecedented, since under most circumstances application of the field decreases the conductance of the solutions, a phenomenon not heretofore observed with any other electrolytes. (auth)

13357 THE WIEN EFFECT IN URANYL ION SOLUTIONS. II. URANYL FLUORIDE FROM 5 TO 65°. Joseph F. Spinnler and Andrew Patterson, Jr. J. Phys. Chem., 69: 508-13(Feb. 1965). (TID-21219)

Experimental measurements of the pH and the low- and and high-field conductances of solutions of uranyl fluoride over the temperature range from 5 through 65°C are

presented as a function of concentration. The salt exhibited a number of unusual properties. In keeping with the findings of earlier investigators, its behavior at low fields was that of a highly associated electrolyte. At high fields, however, it behaved like a relatively strong electrolyte. The pH values were higher than those of other uranyl salts examined in the same range of temperature and concentration. The high-field conductance quotients varied only slightly with increasing temperature. (auth)

13358 THE WIEN EFFECT IN URANYL ION SOLUTIONS. III. URANYL SULFATE FROM 5 TO 65°. Joseph F. Spinnler and Andrew Patterson, Jr. (Yale Univ., New Haven). J. Phys. Chem., 69: 513-17(Feb. 1965). (TID-21320)

The low-field conductance, pH, and high-field conductance of solutions of uranyl sulfate were determined over a range of concentrations and temperatures from 5 through 65°C. Uranyl sulfate was found to be an associated electrolyte, although disagreement between low-field conductance and ligand displacement determinations of the dissociation constant and ambiguities in the high-field conductance results made it impossible to place the dissociation constant precisely. The results were consistent with the conclusion of low-field conductance measurements that the association of the electrolyte increases with increasing temperature. (auth)

13359 MÖSSBAUER EFFECT IN ^{57}Fe IN SINGLE CRYSTALS OF UO_2. Shōichi Nasu, Naomoto Shikazono, and Hidekuni Takekoshi (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 19: 2351-2(Dec. 1964).

Results obtained from an experiment on the Mössbauer resonance corresponding to iron impurities in single crystals of UO_2 are reported. Two samples were prepared by drying $^{57}CoCl_2$ in a hydrochloric acid solution on the surface of UO_2. The $^{57}CoCl_2$ was reduced by heat treatment at 500°C for an hour, and the cobalt was diffused into the crystals by annealing in a hydrogen atmosphere at 1200°C for 60 hours. The Mössbauer patterns and the magnetic field at the iron nucleus are discussed. (C.E.S.)

13360 HEAT CAPACITY AND THERMODYNAMIC PROPERTIES OF BERYLLIUM ALUMINATE (CHRYSOBERYL), $BeO \cdot Al_2O_3$, FROM 16 TO 380 °K. George T. Furukawa and William G. Saba. J. Res. Natl. Bur. Std., 69A: 13-18(Jan.-Feb. 1965).

The thermal capacity of beryllium aluminate (chrysoberyl), $BeO \cdot Al_2O_3$, was determined from 16 to 380 °K and the thermodynamic properties calculated from 0 to 380 °K. (auth)

13361 ATOMIC ABSORPTION SPECTRUM OF PRASEODYMIUM (Pr I). Romuald Zalubas and Michael Wilson. J. Res. Natl. Bur. Std., 69A: 59-70(Jan.-Feb. 1965).

Absorption lines of Pr I were observed using King furnace. A list of 3532 lines in the region from 1741 to 5839 Å is presented. (auth)

13362 THE KINETIC ISOTOPE EFFECT IN DEUTERIUM AND TRITIUM EXCHANGE BETWEEN HYDROCARBONS AND BASES. A. I. Shatenstein, F. S. Yakushin, M. I. Arshinova, and E. A. Yakovleva (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Kinetika i Kataliz, 5: 1000-7(Nov.-Dec. 1964). (In Russian)

Kinetic isotopic effects in deuterium–tritium exchange between indene fluorene, and fluorene methyl-β-naphthyl-ketone with hydrous methylamine, indene with liquid ammonia and toluene, benzene, and naphthalene with potassium amide solution in liquid ammonia were investigated. The magnitudes of the kinetic effects are identical to theoretical values calculated under an assumption of complete bond breakage during the conversion. (tr-auth)

13363 MAGNETIC EVIDENCE FOR TRINUCLEAR CLUSTERS IN RHENIUM(IV) CHLORIDE. R. Colton and R. L. Martin (Univ. of Melbourne). Nature, 205: 239-40 (Jan. 16, 1965).

The magnetic properties of rhenium(IV) chloride were examined and it was found that they can be nicely accommodated on the basis that the compound contains trimeric units, Re_3Cl_{12}. The bonding and magnetism of rhenium(IV) chloride are tractable in terms of a molecular orbital (M.O.) description. An L.C.A.O.-M.O. treatment in the Hückel approximation was used to describe the bonding in the diamagnetic $(Re_3Cl_{12})^{3-}$ anion. An interesting feature that emerged from this treatment was the prediction that a trinuclear rhenium(V) cation $(Re_3Cl_{12})^{3+}$ may exist that could be of comparable stability to the trimer structures already known. (P.C.H.)

13364 SOME NEW COMPOUNDS OF THE TYPE $Me^{II}Me^{III}_2O_4$. Hanskarl Mueller-Buschbaum (Universität, Munster, Ger.). Naturwissenschaften, 51: 508-9(1964). (In German)

The compound $CaSc_2O_4$ was prepared from stoichiometric mixtures of Sc_2O_3 and $CaCO_3$ or $Ca(NO_3)_2$ by annealing for many hours at 1000°C brief heating to 2100°C. The crystal structure of $CaSc_2O_4$ was determined. The compounds $BaSc_2O_4$, $SrSc_2O_4$, and $MgSc_2O_4$ were also prepared, and their crystal type were determined. (J.S.R.)

13365 PROTON SPACE CHARGE IN ANODIC OXIDE FILMS. D. A. Vermilyea (General Electric Co., Schenectady, N. Y.). Phys. Chem. Solids, 26: 133-41(Jan. 1965).

The capacitance of anodic oxide films on niobium, tantalum, tungsten, titanium, and antimony depends strongly on the electrical potential difference across the film during the measurement. With decreasing applied potential the capacitance of the thinner oxide films increases sharply and may reach values of about 100 $\mu F/cm^2$. The capacitance of films formed on aluminum, beryllium, gallium, zirconium, bismuth, and silicon is independent of potential. It is shown that the capacitance increase results from a proton space charge within the film. A quantitative theory is in reasonable agreement with the experimental information. (auth)

13366 SPECIFIC HEAT OF LANTHANUM NITRIDES AND NEODYMIUM NITRIDES. J. J. Veyssie, J. Chaussy, and A. Berton (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). Phys. Letters, 13: 29-30(Nov. 1, 1964). (In French)

The specific heats of LaN and NdN were measured between 1.2 and 45°K in an adiabatic calorimeter provided with a gas thermometer. The results were graphed. No conclusion on the eventual existence of an electron contribution could be made for LaN. In NdN the ferromagnetic transition previously announced was detected at 27.6 ± 0.1°K. The magnetic contribution to the specific heat was evaluated. (J.S.R.)

13367 VAPOR PRESSURE OF LIQUID ARGON. A. Van Itterbeek, J. De Boelpaep, O. Verbeke, F. Theeuwes, and K. Staes (Instituut voor Lage Temperaturen en Toegepaste Physica, Louvain, Belg.). Physica, 30: 2119(Dec. 1964).

The saturated vapor pressure of liquid argon was measured at 34 temperatures between 85.22 and 148.62°K. The results were compared with values obtained from empirical equations and with other determinations. (D.C.W.)

13368 SALT COMPLEXES WITH 5-NITROBARBITURIC ACID. II. COMPLEXES OF 5-NITROBARBITURIC ACID WITH HEXAMETHYLENETETRAMINE AND Ba^{2+}, La^{3+}, Ce^{3+}. Margareta P. Poni, Marcel Bostan, Nicolae Iorga, and Iulian Gabe (Petru Poni Institut de Chimie, Jassy). Rev. Roumaine Chim., 9: 575-84(Oct. 1964). (In Rumanian)

The study of complex salts formed by 5-nitrobarbituric acid with hexamethylenetetramine and with the cations Ba^{2+}, La^{3+}, and Ce^{3+} was continued. The range of stability of these complexes was established by thermodifferential analysis. From these thermogravimetric data, the reaction order and the activation energy of the products obtained after thermal treatment were calculated. It was concluded, from the infrared spectra of the salts studied, that the metal is bound to the carbon in position 5, whereas the

hexamethylenetetramine is fixed coordinatively to the metal. (tr-auth)

13369 OCTAWOLFRAMO-CERITES(III)— A NEW CLASS OF HETEROPOLYCOMPOUNDS. Raluca Ripan and Ioan Todorut (Inst. of Chemistry, Cluj). Roczniki Chem., 38: 1587-92(1964).

Five salts of the new heteropolyanion $[CeW_8O_{28}]^{5-}$ containing trivalent cerium and tungsten anhydride residues were synthesized in the general formula $Me^{(1)}[CeW_8O_{28}] \cdot x H_2O$ (where $Me^1 = Na^+$, K^+, NH_4^+, Rb^+, or Cs^+) as determined by chemical and thermogravimetric analysis. Some physico-chemical properties of these salts were determined. (auth)

13370 PROTON MAGNETIC RESONANCE IN GAMMA-IRRADIATED POLYISOBUTYLENE. N. M. Sergeev and V. L. Karpov (Karpov Inst. of Physics and Chemistry, Moscow). Soviet Phys.-Solid State (English Transl.), 6: 1719-20(Jan. 1965). Translated from Fiz. Tverd. Tela, 6: 1279-80(July 1964).

The proton magnetic resonance of polyisobutylene, (PIB) irradiated with ^{60}Co gamma rays was measured by the modulation method at room temperature. The values obtained for the width of the proton resonance line agree with values given in the literature for unirradiated PIB. (D.C.W.)

13371 FORCE CONSTANT CALCULATION. PART 9. CF_3H AND CF_3D. D. A. Long, R. B. Gravenor, and D. T. L. Jones (Univ. College, Swansea, Wales, U. K.). Trans. Faraday Soc., 60: 1509-14(Sept. 1964).

Since the existing force fields are unsatisfactory for CF_3D, computing techniques were used in an attempt to determine a force field that is equally satisfactory for both CF_3H and CF_3D. Two types of force field were studied: a hybrid orbital force field (HOFF); and the Urey-Bradley-Simanouti field (UBS). The fundamental frequencies for CF_3H used in these calculations are tabulated and reasons for adopting different assignments from those used in previous studies are presented. The various assignments of fundamentals for CF_3H are listed. Since CF_3H belongs to the C_{3v} point group it has six distinct frequencies, three in class a (ν_1, ν_2, and ν_3) and three in class e (ν_4, ν_5, and ν_6). The assignments of each are considered. A band at 1209 cm^{-1} assigned earlier to ν_2 is now assigned as $\nu_3 + \nu_6$. The assignment gives good agreement with the product rule. The values are: class a_1, 1.96, and 1.93; and class e, 1.89, 1.84, for calculated and observed values, respectively. For bond lengths and angles in CF_3H the following values are assumed, C-F bond length 1.332 Å, C-H bond length 1.098 Å, and all interbond angles tetrahedral. The HOFF field is based on orbital following rehybridization arguments and enables off-diagonal stretch-bend interaction constants to be related to the diagonal stretch constants. Class a_1 and e relations were obtained for fluoroform, giving the force constant $\mathcal{F}_{ij}$ relating to the symmetry co-ordinates defined in terms of internal co-ordinates. The computed converged values and dispersions of the $\mathcal{F}_{ij}$ for the HOFF field and the UBS field are given and the calculated frequencies corresponding to the HOFF and UBS fields were compared with the observed frequencies. The converged values of the UBS force constants H_{HCF} and H_{FCF} were both negative, giving serious doubts about the physical meaning of these values. Comparison of the $\mathcal{F}_{ij}$ values corresponding to the UBS constants with those obtained for other fields confirmed this. The HOFF form was more acceptable since it reproduced the observed frequencies well and the $\mathcal{F}_{ij}$ values were more reasonable. It was concluded that in fluoroform, hybrid orbital arguments form a sound basis for interrelating force constants and so reducing the number of independent force constants whereas the UBS model is not satisfactory. (BBB)

13372 STUDY OF THE SURFACE AND BULK HYDROXYL GROUPS OF SILICA BY INFRA-RED SPECTRA AND D_2O-EXCHANGE. V. Ya. Davydov, A. V. Kiselev, and L. T. Zhuravlev (Moscow State Univ. and Inst. of Physical Chemistry, Academy of Sciences, USSR). Trans. Faraday Soc., 60: 2254-64(Dec. 1964).

The hydroxyl groups of silica (aerosols and silica gels) are divided into surface and bulk groups. The surface OH groups are rapidly substituted by OD, making it possible to determine the surface concentration of hydroxyl groups by exchange between the samples and D_2O vapor at ordinary temperatures, as well as the total amount of OH groups in the sample by exchange between D_2O vapor and the entire quantity of water evolved when the sample is heated to 1200°C. The isotopic composition of the vapor after deuterium exchange was determined by mass spectrometry. Deuterium exchange was also studied by infrared spectroscopy. The ratio between the quantities of surface and bulk OH groups depended on the pre-treatment of the sample, and on the size of the silica globules. The concentration of OH groups on the surface of maximally hydroxylated samples was practically independent of their history and dispersity. Surface OH groups could be subdivided in turn into free and bound groups. The main role in specific adsorption (when hydrogen and similar bonds were formed with the adsorbate molecules) and in the chemical reaction with trimethylchlorosilane had to be credited to the free hydroxyl groups of the silica surface. (auth)

13373 STUDIES ON REACTION OF FLAVONE DERIVATIVES WITH STRONTIUM. I. ON THE PRECIPITATING REACTION OF FLAVONE DERIVATIVES WITH STRONTIUM. Nobuhiko Iritani, Yoshio Takino, Toyoko Nakano, and Shunsuke Kazama (Shizuoka Coll. of Pharmacy, Japan). Yakugaku Zasshi, 84: 1119-23(Nov. 1964). (In Japanese)

Some flavone derivatives reacted with Sr^{2+} to produce yellow, brown, to black precipitates in ammoniacal methanol solution. The reaction was more sensitive than the usual Mg + HCl reaction. To investigate the precipitation reaction, six kinds of methylated quercetin derivates, the five hydroxyl groups of which are totally or partially methylated, were studied with Sr^{2+} for precipitate formation. The results showed that 3,5,7,3′,4′-pentamethoxy-flavone, 5-hydroxy-3,3′,4′7-tetramethoxyflavone, 3-hydroxy-3′, 4′,5,7-tetramethoxyflavone, and 3,4′5,7-tetrahydroxy-3′-methoxyflavone were unreactive with Sr^{2+}. However, 3,4′,5,7-tetrahydroxy-3′-methoxyflavone and 3′,4′,5-trihydroxy-3,7-dimethoxyflavone showed positive reactions. In the reaction products with quercetin and 3,4′,5-trihydroxy-3,7-dimethoxyflavone, the Sr contents were determined quantitatively and the binding molar ratio of flavone derivatives and Sr was found to be 1:1. Therefore, the hydroxyl groups at 3′-and 4′-position of flavone derivatives were considered to participate in the precipitation reaction with Sr^{2+}. (BBB)

13374 COMPLEXES OF METALLOCHROMIC SUBSTANCES. V. OPTIMUM CONDITIONS FOR METAL COMPLEX FORMATION AND THEIR RELATION TO THE COMPLEX COMPOSITION. B. Budesinsky (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). Z. Anal. Chem., 207: 247-56(1965).

The general equation of optimum metal complex formation makes possible the description of the optimum conditions of existence for every assumed metal complex composition. This equation was applied to metal complexes of EDTA, xylenol orange, methylthymol blue, pyrocatechol violet, eriochrome black T, arsenazo I, and arsenazo III. The results obtained were in good agreement with practical experiences. Theoretical conclusions showed the impossibility of the existence of an universal optimum spectrophotometric reagent for the determination of metals. (auth)

13375 BOND LENGTHS IN XENON(II) FLUORIDE. P. J. Gellings (Technische Hogeschool Twente, Enschede, Netherlands). Z. Physik. Chem. (Frankfurt), 43: 123-5 (Oct. 1964).

In considering the 110 plane of the XeF_2 unit cell, three forces to which one fluorine atom is subjected were analyzed to explain the increase in Xe–F bond lengths upon solidification. The downward force due to repulsion by another fluorine atom, the downward force due to attrac-

tion by a xenon atom, and an upward force due to another fluorine atom would account for an increase of about 10% in the Xe–F distance upon solidification. Polarization of the F atoms and increase of coordination number with resulting increase in atomic distances made smaller contributions to the increased distance in the solid. The direct electrostatic interaction was the primary cause of the increased distance. The same forces resulted in the similar but smaller Xe–F distances in XeF_4. (J.S.R.)

13376 CONTRIBUTION TO THE LUMINESCENCE BEHAVIOR OF BIACTIVATED CALCIUM OXIDE–PRASEODYMIUM PHOSPHORS. Hans Witzmann, Gerhard Herzog, and Gunter Kunze (Universitat, Greifswald, Ger.). Z. Physik. Chem. (Leipzig), 227: 33-9(1964). (In German)

Intensity vs temperature curves are presented and discussed for the calcium oxide-praseodymium-Me(Me = Au and Li) phosphor system. For the gold-containing system, the optimum preparation conditions were a 20-min heating at 1000°C and an Au concentration of 3×10^{-4} g at. % Pr. (OTS)

13377 STUDIES ON THE EFFECT OF LIGHT ON THE ISOTOPE-EXCHANGE REACTIONS IN THE $[PtCl_4]^{2-} + Cl^{-1}$ SYSTEM. R. Dreyer, K. Koenig, and H. Schmidt (Zentralinstitut fur Kernforschung, Rossendorf, Ger. and Kernphysikalisches Institut Zeuthen, Deutsche Akademie der Wissenschaften, Berlin). Z. Physik. Chem. (Leipzig), 227: 257-71(1964). (In German)

The isotope exchange reaction was investigated at illuminations of 546 to 230 nm wavelength, 0.1 to 5N HCl concentrations and 25 to 80°C temperature with the aid of ^{36}Cl-labeled $K_2(PtCl_4)$. The results are presented and discussed. They indicated that a chain mechanism prevails in the isotope-exchange reaction. (OTS)

13378 ELECTRONIC DEFECTS AS REACTION INTERMEDIATES IN SODIUM CHLORIDE FILMS. Richard James Adams. Thesis, Vancouver, Can., Univ. of British Columbia, 1964. 138p.

Evaporated films of radioactive sodium chloride were prepared by direct sublimation onto a water-cooled quartz substrate at 10^{-5} mm of mercury. These possess specific surfaces of from 30-100 m^2/g and show remarkably high exchange reactivity to chlorine. The role of electronic defects in the exchange mechanism was studied from the pressure and temperature dependence of the exchange rate and from the effect of introducing electronic defects by x irradiation or fluorination. These latter processes cause the kinetics of the reaction to change completely to a second-order law, and provide strong evidence to support an earlier tentative suggestion that electronic defects are involved in the reaction and that a process of adsorption of a chlorine molecule into a pair of defects is important. Detailed mechanisms are proposed for both the power law and the second-order reactions, largely on the basis of the pressure dependence. Both mechanisms use two species of electronic defect, corresponding to Seitz's models for V_2 and V_4 centers, and the power law mechanism requires a transition complex between the two defects. Measurements by x-ray diffraction on the particle size in the evaporated films showed them to be in the range 250-500 Å, and an estimate of the strain from the same results suggests that roughly one dislocation per particle is present. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13379 STUDIES OF SELECTED POLYANIONS IN AQUEOUS SOLUTION: THE HEXANIOBATE AND THE HEXATANTALATE. Wilfred Herding Nelson. Thesis, Minneapolis, Univ. of Minnesota, 1963. 171p.

The ionic charge and the degree of polymerization were determined simultaneously for isopolyniobates and isopolytantalates in alkaline aqueous solutions of 1.000 M KCl using the experimentally independent methods of equilibrium ultracentrifugation and light scattering. It was demonstrated that the niobate and the tantalate anions in the solutions were essentially those found in crystals. The effective ionic charge is reduced because of the binding of counterions in solution to a value of about –2. Generally the effective charge on the niobate ion is slightly lower than that of the tantalate because of protonation. Anion exchange chromatography confirms this conclusion. Potentiometric measurements with a glass electrode and ultraviolet absorption spectra in the pH range 11 to 13 show that the stoichiometry of the dissolved tantalate is essentially the same as that found in the crystalline compound $K_8Ta_6O_{19} \cdot 16H_2O$. Ultracentrifugation at pH 11.5 demonstrated the absence of any appreciable amount of niobate or tantalate species with degrees of polymerization appreciably different from 6. In the light scattering study, turbidities and refractive indices were measured at 4358 Å. Square 30 × 30 mm cells were used for turbidity measurements. Sedimentation equilibrium experiments were performed using both schlieren and Rayleigh interference optical systems. Measurements were made at 5461 Å. The advantages of the two methods of analysis are compared. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13380 PROTON MAGNETIC RESONANCE IN METHANE AND ITS DEUTERATED MODIFICATIONS. Harbhajan Singh Sandhu. Thesis, Vancouver, Can., Univ. of British Columbia, 1964. 98p.

A study of proton magnetic resonance in methane and its deuterated modifications is reported. The measurements of nuclear spin relaxation times were carried out at a frequency of 30 Mcps using pulse techniques in samples of CH_4, CH_3D, CH_2D_2, and CHD_3. The spin-lattice relaxation time T_1 was measured in liquid and solid samples between 110°K to 56°K. Results show that T_1 is temperature-dependent and this temperature dependence is independent of the number of deuterons in the samples. The simplest possible interpretation of the results in both the liquids and solids is that only one mechanism, that associated with the inter-molecular dipolar interactions, is probably predominant in causing relaxation. The spin-rotational interactions and intramolecular interactions do not seem as important as predicted by conventional theory. The effect of dissolved paramagnetic ions was also studied. T_1 was also measured in pure samples and in liquid and solid samples of CH_4 (110°K–78°K) containing 1.08% and 2.54% oxygen. The results verify the inverse proportionality of T_1 to the concentration of oxygen. The spin-spin relaxation time T_2 was measured in liquid and solid samples between 110°K and 56°K. The results show that the line shape is predominantly due to inter-molecular interactions. Furthermore, the resonance line has a Gaussian shape at temperatures ≤65°K and changes to a Lorentzian shape at higher temperatures. The activation energies from T_2 measurements are found to be 3.2 kcal/mole independent of the number of deuterons in the samples. These results agree with the values of activation energies obtained from T_1 measurements in the solids just below the melting point (80°K–90°K). (Dissertation Abstr., 25: No. 4, Oct. 1964).

13381 AN INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE NUCLEAR SPIN-LATTICE RELAXATION TIME OF FLUORINE NUCLEI IN SINGLE CRYSTALS OF CALCIUM FLUORIDE DOPED WITH RARE-EARTH AND ACTINIDE ELEMENTS. Morgan Albert Waldrop. Thesis, Houston, Tex., Rice Univ., 1964. 117p.

The temperature dependence of the nuclear spin-lattice relaxation time of fluorine nuclei in single crystals of calcium fluoride doped with rare-earth and actinide elements was measured from 1.3 to 300°K by pulsed nuclear magnetic resonance techniques at 6 Mcps. Nuclear relaxation times were measured in crystals doped with uranium, erbium, samarium, and europium. Analysis of the nuclear relaxation data using the theory of nuclear relaxation by paramagnetic impurities indicates that the spin-lattice relaxation time of the paramagnetic impurities must be described by the Van Vleck one-phonon direct process at low temperatures and by the Orbach two-phonon resonant process at intermediate temperatures (less than 100°K). Agreement with theoretical predictions is only qualitative. The relatively high impurity concentration in these commercially-prepared crystals weakens the assumption,

basic to the theory, that impurity spin-spin interactions may be neglected. However, the experiment indicates that impurity relaxation times can be determined from the nuclear spin-lattice relaxation time over a fairly wide temperature range with this technique if more dilute samples can be obtained. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13382 CONDENSATION AND EVAPORATION OF SOLIDS. Proceedings of the International Symposium, Dayton, Ohio, September 12-14, 1962. Emile Rutner, P. Goldfinger, and J. P. Hirth, eds. Materials Science and Engineering Program. New York, Gordon and Breach Science Publishers, 1964. 721p. (CONF-620902)

Proceedings of the International Symposium on Condensation and Evaporation of Solids are presented. The 45 papers or abstracts of papers cover the following topics: condensation rates and mechanisms, experimental determination of condensation rates, evaporation rates and mechanisms, mass spectral studies of evaporation rates and processes, and techniques for studying evaporation phenomena. (M.C.G.)

13383 ADVANCES IN QUANTUM CHEMISTRY. VOLUME I. Per-Olov Loewdin, ed. New York, Academic Press, 1964. 394p.

Developments in quantum chemistry, which deals with the electronic structure of atoms, molecules, and crystalline matter and describes it in terms of electronic wave patterns, are surveyed. Topics covered include: the Schrödinger two-electron atomic problem, energy band calculations by the augmented plane wave method, spin-free quantum chemistry, methods of calculating molecular electronic wave functions, theory of solvent effects on molecular electronic spectra, the π-electron approximation, recent developments in the generalized Hückel method, accuracy of calculated atomic and molecular properties, and recent developments in perturbation theory. (M.C.G.)

13384 INERTNYE GAZY. (Inert Gases). V. G. Fastovskii, A. E. Rovinskii, and Yu. V. Petrovskii. Moscow, Atomizdat, 1964. 302p.

Physical and physico-chemical properties of inert gases (helium, neon, argon, krypton, and xenon) and their applications in chemical, metallurgical, atomic, and other branches of industry are discussed. Descriptions are given of the technology for preparation, separation, and purification of the gases. Applications of gases as protective media are also discussed. (R.V.J.)

13385 MOLTEN SALT CHEMISTRY. Milton Blander, ed. New York, Interscience Publishers, 1964. 781p.

Information is included on: equilibrium theory of pure fused salts; diffraction studies of the structure of molten salts; thermodynamic properties of molten salt solutions; phase diagrams of fused salts; mixtures of metals with molten salts; electronic absorption spectra of molten salts; vibrational spectra of molten salts; transport properties of molten salts; structures and themochemistry of metal halide vapors; and electroanalytical chemistry of molten salts. (P.C.H.)

13386 RARE EARTH RESEARCH II. Proceedings of the Third Conference on Rare Earth Research, [Clearwater, Fla.], April 21-24, 1963. Karl S. Vorres, ed. Materials Science and Engineering Program. New York, Gordon and Breach, Science Publishers, 1964. 635p. (CONF-20)

Fifty papers are included; separate abstracts were prepared for 15. Four papers on preparation of stable cerous oxide, rare earths in optical maser materials, magnetic behavior of samarium iron garnet in cubic approximation, and fluorescence of Tb^{3+} abd $Tb^{3+} - Eu^{3+}$ in fused silica were not abstracted in NSA. 31 papers were previously abstracted in NSA as 17: 14216, 14376, 14823, 14824, 15950, 15951, 18761, 25165, 29440, 30506, 30556, 30557, 30965, 31011, 32033, 32035, 32124, 32125, 32651, 32654, 32818, 32819, 33861, 33870, 33949, 33964, 34655, 39025, and 18: 1644, 13868, and 25981. (P.C.H.)

For abstracts of individual papers see: 13387, 13388, 13389, 13390, 13391, 13392, 13393, 13394, 13395, 13396, 13397, 13398, 13399, 13400, and 13620.

13387 STUDIES OF SOME EUROPIUM(II) COMPOUNDS. G. Garton and D. A. Hukin (Clarendon Lab., Oxford). p.3-10 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

Methods for preparing europium(II) oxide, EuO, are reported. Of four different methods that were used to obtain EuO, only two appeared to have any value as preparative methods. First, oxidation of Eu by oxygen at low pressures can be made to yield pure EuO by adding slightly less than the theoretical amount of oxygen and distilling of the excess Eu. Second, thermal decompositions of europium(II) hydroxide also provides a good method of preparing EuO since it requires no elaborate apparatus and the starting material is easy to prepare from available chemicals. Both of these methods gave dark-purple EuO, analytically pure according to gravimetric estimation of Eu by ignition to Eu_2O_3, and according to the evidence of x-ray diffraction. Thermal decomposition of europium(II) carbonate and formate resulted in EuO more or less heavily contaminated with Eu_2O_3. Another compound, $Eu(II)_3Al_2(SiO_4)_3$, a Eu(II) analog of natural garnet, was prepared by sintering together an intimate mixture of EuO, Al_2O_3, and SiO_2. (P.C.H.)

13388 A JOINT REPORT ON THE SIMULTANEOUS INDEPENDENT WORK IN THREE LABORATORIES ON THE SOLVOLYTIC DISPROPORTIONATION OF INTERMEDIATE HIGHER OXIDES, $(R.E.)O_x$ $(1.50 < x < 2.00)$, INTO (R.E.) (III) AND $(R.E.)O_2$. A. F. Clifford (Purdue Univ., Lafayette, Ind.). p.45-50 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

It was demonstrated, simultaneously in three different laboratories, that leaching of the intermediate oxides of the rare earth elements with appropriate solvents results in disproportionation of the oxides to the bracketing stable integral oxidation states, in the cases examined with production of a solid phase having the chemical analysis and crystal structure of the dioxide. It appears, however, that at least in the case of acetic acid leachings the oxide always retains, presumably on the surfaces of the particles, some of the acid used (or its anion) tightly enough absorbed to resist removal by washing with water. The experimental work was performed on PrO_x and TbO_x. (P.C.H.)

13389 BASIC RARE EARTH AZIDES. H. Rosenwasser and J. I. Bryant (USAERDL, Fort Belvoir, Va.). p.75-86 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

A number of lanthanon sesquioxides, as well as Pr_6O_{11} and Y_2O_3, were reacted with hydrazoic acid solution. Basic rare earth azides were obtained from the filtrate by precipitating out with acetone. X-ray powder diffraction patterns showed that two isostructural groups were present. Chemical analysis indicated a metal to nitrogen ratio that supported the composition $Ln(OH)_2N_3 \cdot \frac{1}{2}H_2O$ for the La-type and $Ln_2(OH)_5N_3 \cdot H_2O$ for the Ho-type. Infrared spectral data, however, can best be explained if the oxo-compounds are postulated. (auth)

13390 ELECTRON MICROPROBE DETERMINATION OF COBALT–DYSPROSIUM COMPOUNDS. J. D. Wood and G. P. Conard, II (Lehigh Univ., Bethelem, Penna.). p.209-17 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

Seven compounds were observed in the cobalt-dysprosium system by electron microprobe analysis. The stoichiometries of five of these compounds were identified as Co_5Dy, Co_7Dy_2, Co_3Dy, Co_2Dy, and $CoDy_3$. The other two compounds were tentatively identified as Co_2Dy_3 and Co_5Dy. X-ray investigation substantiates the existence of the seven compounds. In addition a partial Co-Dy phase diagram is proposed based upon evidence obtained using metallographic and thermal analysis techniques along with the electron microprobe and x-ray analyses. The diagram contains at

least three eutectics—between Co and Co_3Dy, between Co_2Dy and Co_2Dy_3 and between Co_2Dy_3 and $CoDy_3$. (auth)

13391 SPECIFIC HEAT OF Ce, Pr, Nd, Eu, AND Lu METALS BETWEEN 0.4 AND 4°K. O. V. Lounasmaa (Argonne National Lab., Ill.). p.221-31 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

The specific heat of Ce, Pr, Nd, Eu, and Lu metals was measured between 0.4 and 4°K in a ^3He cryostat. Whenever possible, the observed C_p was analyzed into its various contributions, viz. lattice, electronic, magnetic, and nuclear specific heats. An estimate of the low temperature Debye characteristic temperature for all trivalent rare earths is also given. (auth)

13392 PHASE RELATIONSHIPS IN THE PrO_x SYSTEM. B. G. Hyde, D. J. M. Bevan, and Leroy Eyring (Arizona State Univ., Tempe). p.277-96 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

A phase diagram (p,x,T) for the system PrO_x which would appear to be qualitatively in agreement with all the available experimental data; the agreement is quantitative in some instances. Those data correlated in this way include: all the isotherms $(p,x)_T$; DTA and TGA plots; results of x-ray diffraction studies; kinetics of oxidation and reduction, insofar as these are known; hysteresis effects; and break pressure phenomenon in the oxidation of $PrO_{1.5}$. A necessary elaboration of earlier approaches to nonstoichiometry and hysteresis is put forward, and utilized in a partial interpretation of the latter in composition changes in both PrO_x and PdH_x. (P.C.H.)

13393 CRYSTAL CHEMISTRY AND PHASE EQUILIBRIA OF THE La–Te SYSTEM. T. H. Ramsey, Hugo Steinfink, and E. J. Weiss (Univ. of Texas, Austin). p.303-14 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

Studies were made on the crystal chemistry, phase equilibria, and physical properties of compounds formed in the La-Te system. Four phases were identified: $LaTe_3$, $LaTe_2$, La_2Te_3-La_3Te_4, and LaTe. Data on physical properties and structure are tabulated. (P.C.H.)

13394 INVESTIGATIONS OF THE PRASEODYMIUM–NEODYMIUM SYSTEM. C. E. Lundin, J. F. Nachman, and A. S. Yamamoto (Univ. of Denver). p.315-28 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

The phase equilibria of the praseodymium-neodymium system were determined by metallographic, x-ray diffraction, thermal analytical, and theoretical and observed density measurements. Complete solid solubility exists in the high-temperature body-centered-cubic phase and the low-temperature hexagonal close-packed phase. An examination of the low-temperature phase for solution ideality was conducted. On the basis of the experimental data, the solid solution of this system exhibits essentially complete ideality. (auth)

13395 REFRACTIVITIES OF THE RARE EARTH OXIDES. Ernest M. Levin (National Bureau of Standards, Washington, D. C.). p.339-50 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

Index of refraction and density data obtained for a number of rare earth borates (ABO_3) and aluminates and gallates ($A_3B_5O_{12}$) permitted the calculation of the specific refractivities (by the Gladstone and Dale formula) of the rare earth sesquioxides. This was done using the additive rule between the products of the specific refractivities and the weight fractions of the constituent oxides. The specific refractivity values decreased with decreasing ionic radius of the cation, ranging from 0.148 for La_2O_3 to 0.107 for Dy_2O_3 to 0.090 for Lu_2O_3, and include the lowest values ever reported for oxides. Specific refractivities and molar refractivities (Lorentz-Lorentz formula) were calculated also from data on crystal fragments of the cubic rare earth oxides, obtained from two sources. Specific refractivities decreased from a value of 0.120 for Dy_2O_3 to 0.099 for Lu_2O_3, and were 10 to 13% higher than those calculated from the binary oxide compounds. Molar refractivities (Lorentz-Lorentz) of the pure oxides varied from 22.5 for Dy_2O_3 to 20.2 for Lu_2O_3 and were in good agreement with reported data. (auth)

13396 FERROMAGNETISM IN Gd–Bi, Sb COMPOUNDS WITH THE Th_3P_4 STRUCTURE. F. Holtzberg, S. Methfessel, and J. C. Suits (International Business Machines Corp., Yorktown Heights, N. Y.). p.385-99 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

An investigation was made on the magnetic, electrical, and structural properties of Gd_4Bi_3, Gd_4Sb_3, and their solid solutions, which were found to be ferromagnetic with surprisingly high Curie temperatures. The results of the magnetic and electric measurements indicate that the compounds $Gd_4(Sb_xBi_{1-x})_3$ are metallic with electric properties similar to the Gd metal. Data are tabulated. (P.C.H.)

13397 CRYSTAL FIELD EFFECTS IN METALLIC CERIUM, PRASEODYMIUM AND NEODYMIUM. B. Bleaney (Univ. of Pittsburgh). p.417-29 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

The hexagonal phases of cerium, praseodymium, and neodymium contain alternate layers of ions whose immediate neighbors are either in a face-centered cubic or hexagonal arrangement. The crystal field was computed on this model, neglecting small distortions. With appropriate parameters for the terms of fourth and sixth degree, a good fit to the anomalous specific heat of praseodymium metal was obtained. The susceptibility can be explained using a ferromagnetic exchange constant. In cerium, which has a complex phase change, the fit is less good, and an antiferromagnetic exchange constant is required to fit the susceptibility. Preliminary work on neodymium suggests a ground state with the correct entropy, and the magnetic moments in the co-operative phases of both Ce and Nd are consistent with the observed values. (auth)

13398 THE PREPARATION AND THE THERMOELECTRIC PROPERTIES OF SOME RARE-EARTH TELLURIDES. Walter L. Mularz and Stanley J. Wolnik (Avco Corp., Wilmington, Mass.). p.473-9 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

The rare earth compounds, La_3Te_4, La_2Te_3, Ce_3Te_4, Ce_2Te_3, Nd_2Te_3, Nd_3Te_4, Dy_3Te_4, and Pr_2Te_3 were synthesized, and their thermoelectric properties at room temperature were determined. X-ray patterns show them to possess the Th_3P_4 type structure. Data on electric conductivity, apparent thermal conductivity, and thermoelectric power are tabulated. (P.C.H.)

13399 MAGNETIC PROPERTIES OF SOME CUBIC LANTHANON LAVES COMPOUNDS. B. Bleaney (Univ. of Pittsburgh). p.499-506 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

The crystal field was estimated for the lanthanon ions in cubic Laves compounds, type AB_2, and the low lying levels determined. The magnetic moments of the ground states are given, together with the maximum moment which can be obtained by admixture of the nearest excited states by exchange interaction, an effect that is particularly important when the crystal field ground state is a singlet. It is shown that fair agreement is obtained with the magnetic moments of the $LnNi_2$ series, the admixtures being more important when the Curie temperature lies near or above the excited crystal field levels. A plausible interpretation is offered for the moments of the $LnCo_2$ series, regarded as ferrimagnetics with the cobalt moment parallel or antiparallel to the lanthanon moment, according to the effective sign of the lanthanon-cobalt exchange interaction. (auth)

13400 ELECTRICAL CONDUCTIVITY OF NEAR-STOICHIOMETRIC α-CeO_2. E. H. Grenner, J. M. Wimmer, and W. M. Hirthe (Marquette Univ., Milwaukee). p.539-54 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

The electric conductivity of near-stoichiometric α-CeO_2 was determined as a function of oxygen pressure at various

temperatures in order to determine if a correlation of defect structure and conductivity can be made. It was found that the degree of the dependence of electrical conductivity on oxygen pressure increased with increasing temperature with x reaching a value of five at temperatures greater than 1100°C in the relation $\sigma \alpha P_{O_2}^{1/x}$. After a $P_{O_2}^{1/5}$ law for the defect controlled conductivity was found, mass action considerations require that the experimentally determined activation (2.2 ev) be multiplied by five to determine the true activation energy for the defect. Thus a value of 11.0 ev, which can be regarded as being partitioned into the energy for the dissolution of oxygen (creation of defect) and creation of conduction electrons, would be obtained. (P.C.H.)

13401 MOLECULAR DYNAMICS INVESTIGATED BY NEUTRON SCATTERING. J. A. Janik (Inst. for Nuclear Physics, Krakow). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/56, 37p. (CONF-804-4)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

A short review is presented of the problem of applicability of the Krieger-Nelkin theory as well as of the Griffing theory to gases. Then, on the basis of experiments with liquid methane, the applicability of the mass tensor concept to molecules in condensed states is criticized. Strong arguments against the application of the Krieger-Nelkin theory to condensed states are: a shift of neutron energy distribution after scattering towards higher energies and the lack of dependence of the inelastic part on the scattering angle. The rotational dynamics of ammonium groups in ammonium compounds are discussed, with specific consideration of experiments with ammonium halides. For some substances a freedom of rotation of NH_4 groups was obtained from neutron measurements, whereas for some others the rotation goes over into torsional vibration. In this case, frequencies of torsional vibrations obtained from neutron experiments were compared with those obtained from infrared spectroscopy and specific heat measurements. The barrier to rotation evaluation from total neutron cross section measurements is also discussed. Finally a comparison is made of the rotational dynamics of NH_4 groups in NH_4ClO_4 and H_3O groups in H_3OClO_4 on the basis of neutron inelastic scattering experiments. A free rotation of the NH_4 group in ammonium perchlorate was obtained even at temperatures as low as liquid nitrogen temperature. For H_3OClO_4 a torsional vibration of the H_3O group with a frequency of 497 cm^{-1} was obtained. So in spite of the identity of the crystal lattices of NH_4ClO_4 and H_3OClO_4 the dynamics of the NH_4 and H_3O groups are different. The results are compared with those known from Raman spectroscopy and NMR. (auth)

Organic Chemistry

13402 (KFK-244) UBER DEN MECHANISMUS DER THERMISCHEN, PHOTOCHEMISCHEN UND STRAHLENCHEMISCHEN CIS-TRANS-ISOMERISIERUNG. (The Mechanism of Thermal, Photochemical, and Radiation Chemical cis-trans Isomerization). Hans Guesten (Kernforschungszentrum, Karlsruhe, Germany). July 1964. 190p. Dep.(mn).

The thermal, photochemical, and radiation chemical cis-trans transformation was investigated on various substituted stilbenes. In the thermal isomerization, special emphasis was placed on the effect of electron acceptors and donors as substitutes to the isomerization. In the photochemical studies, the mechanism of the isomerization and the chemical behavior of electronically excited states were investigated. The experimental results are discussed in detail and related to previous studies. 244 references. (J.S.R.)

13403 (NRS-24) ION-MOLECULE REACTIONS IN KETONES. B. C. de Souza and J. H. Green (New South Wales Univ. of Technology, Kensington). 1964. 16p. Dep.(mn).

Reactions with gaseous ketones in the ion source of a mass spectrometer at elevated pressures were studied. Reaction cross sections and approximate rate constants are reported for reactions leading to ions of mass M + 1, where M is the mass of the parent ion. The relevance of the results to the radiation chemistry of organic oxygen compounds is discussed briefly. (auth)

13404 (ORINS-46) A CHEMICAL STUDY OF AN AMBIENT TEMPERATURE CATALYTIC BENZENE SYNTHESIS USED IN RADIOCARBON DATING. J. E. Noakes, S. M. Kim, G. A. Thomas, and L. K. Akers (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). [nd]. Contract [AT(40-1)-Gen-33]. 12p. Dep.; $1.00(OTS).

A chemical study was made of an ambient temperature catalytic method for synthesizing liquid benzene from acetylene gas in a manner ideally suited for liquid scintillation radiocarbon dating. The benzene synthesis was studied as six specific steps with optimum conditions determined for catalyst preparation and acetylene catalysis which has resulted in benzene yields of greater than 90%. Infrared and gas chromatographic analyses were used to check the purity of the synthesized benzene and mass spectrometry to evaluate possible chemical carbon isotope fractionation. (auth)

13405 (UCRL-7741) COUPLING OF FLUOROALKYL IODIDES. Eugene R. Bissell (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 28, 1964. Contract W-7405-eng-48. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The coupling of haloalkyl iodides by irradiation with ultraviolet light in the presence of mercury has been extended to fluorocarbons containing CHClI and CHFI groupings as the reactive sites. Both meso and racemic isomers of 2,3-dichloro- 1,1,1,4,4,4-hexafluorobutane and of 1,4-dichloro- 1,1,2,3,4,4-hexafluorobutane have been prepared in high purity and characterized by measurement of physical properties and infrared and n.m.r. spectra. (auth)

13406 (JPRS-28565) ORGANO-METALLIC ADDITIVES IN POLYSTYRENE. E. (Ye.) E. (Ye.) Baroni, S. F. Kilin, T. N. Lebsadze, I. M. Rozman, and V. M. Shoniya. At. Energ. (USSR), 17: 497-500(1964). 9p. (TT-65-30247). $1.00(OTS).

In order to obtain polystyrenes containing Pb, Bi, Hg, Sn, and Se, the solubility of their phenyl compounds was determined in the monomer. Detailed methods are described for the thermal polymerization of styrene with these compounds. Data are given for polymers with an added quantity of the phenyl compounds equaling 12 wt % Pb, 19 wt % Bi, 33 wt % Hg, 12 wt % As, 11 wt % Sn, and 10 wt % Se. The polymers were obtained as clear, air-stable substances. These materials were designed as scintillation detectors for gamma radiation and neutrons. Data are given on the luminescence efficiency of plastic scintillators containing Pb, Hg, and Sn. (auth)

13407 SECONDARY KINETIC ISOTOPE EFFECTS IN BIMOLECULAR NUCLEOPHILIC SUBSTITUTIONS. II. ALPHA-DEUTERIUM EFFECTS IN MENSCHUTKIN REACTIONS OF METHYL IODIDE. K. T. Leffek and J. W. MacLean (Dalhousie Univ., Halifax, N. S.). Can. J. Chem., 43: 40-6(Jan. 1965).

Secondary deuterium isotope effects were measured for the reactions between methyl and methyl-d_3 iodides and a series of tertiary amines in benzene solvent. Deuterium substitution increased the rate of each reaction but the rate ratios (k_H/k_D) showed no systematic change with variation in the structure of the amine. The isotope effect for the reaction with 2-picoline was measured at different temperatures over a range of 40 deg and showed no change. The isotope effects may be rationalized as internal rotational effects of the methyl group or as solvation effects. (auth)

13408 SYNTHESIS OF METHYLMALONIC ACID–$^{14}CH_3$. SIDE REACTIONS IN THE ALKYLATION OF ETHYL MALONATE. J. Benes, M. Dobiasova, and K. Veres (Inst. for Biological Research, Prague). Collection Czech. Chem. Commun., 29: 3178-81(Dec. 1964).

Ethyl malonate was alkylated with one equivalent of methyl iodide labeled with ^{14}C. The mixture of malonic acid esters was analyzed by gas chromatography. The formation of mixed esters was proved by detection of radioactivity in the ester group of the malonates. (M.C.G.)

13409 SYNTHESIS OF MERCURY-203 LABELED ORGANOMERCURIC COMPOUNDS. Mo-hsiung Yang and Chau-ting Chang (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 69-70(Feb. 1964).

Mercuric acetate was irradiated at a neutron flux of 10^{12} or 3×10^{12} n/cm^2-sec for at least 30 hr. The target was dissolved in nitric acid and hydrogen peroxide. Mercuric oxide was precipitated in this solution with sodium hydroxide. Acetic acid and benzene were added to the mercuric oxide, and the mixture was refluxed over a water bath for 9 hrs. Phenylmercuric acetate was obtained upon removal of the excess acetic acid and benzene; the yield was generally above 80%. Phenylmercuric iodide and phenylmercuric chloride were obtained by adding alcoholic solution of phenylmercuric acetate to KI and KCl solutions, respectively. The chemical purity of the compounds was investigated by melting point measurements; and, for phenylmercuric acetate, chromatographic determination was performed. Examination of the specific activities of the compounds indicated that enriched ^{203}Hg should be used. (D.C.W.)

13410 ACYLAL HYDROLYSIS. THE HYDROLYSIS OF GAMMA-ETHOXY-GAMMA-BUTYROLACTONE. Thomas H. Fife (Univ. of Southern California, Los Angeles). J. Am. Chem. Soc., 87: 271-5(Jan. 20, 1965).

The hydrolysis of γ-ethoxy-γ-butyrolactone to β-formylpropionic acid was studied as a function of pH in water and in 50% dioxane-water at 30°C. At low pH a specific hydronium ion catalyzed reaction takes place which on the basis of D_2O solvent isotope effects ($k_{D2O}/k_{H2O} = 2.37$) and the entropy of activation (−6.9 eu) can most probably be regarded as an A-1 reaction, proceeding by a pre-equilibrium protonation followed by a unimolecular decomposition of the protonated intermediate. The pH-rate profile shows a large plateau in the pH range 5 to 9, which is most likely due to an Sn1-type reaction in which the carboxylate anion acts as the leaving group. At alkaline pH values hydroxide ion catalysis occurs. (auth)

13411 THE PRIMARY CARBON ISOTOPE EFFECT ON THE IONIZATION OF TRIPHENYLMETHYL CHLORIDE. EXPERIMENTAL DETERMINATION, THEORETICAL JUSTIFICATION, AND IMPLICATIONS FOR CARBON ISOTOPE EFFECTS ON NUCLEOPHILIC SUBSTITUTION AT SATURATED CARBON. A. J. Kresge, N. N. Lichtin, K. N. Rao, and R. E. Weston, Jr. (Boston Univ., Brookhaven National Lab., Upton, N. Y., and Illinois Inst. of Tech., Chicago). J. Am. Chem. Soc., 87: 437-45(Feb. 5, 1965). (TID-21266)

The ^{13}C isotope effect on the ionization of triphenylmethyl chloride to triphenylcarbonium ion was determined by measuring the electric conductivities of normal triphenylmethyl chloride and triphenylmethyl-1-^{13}C chloride in liquid sulfur dioxide solution at 0°C: $K_{12}/K_{13} = 0.9833 \pm 0.0032$. A theoretical analysis of this isotopic system showed that this inverse isotope effect can be reproduced in a model system of abbreviated "molecules," which consist only of the isotopically substituted atom and the atoms bonded directly to it. This analysis also revealed that the cause of the inverse isotope effect in the real system must be much stronger carbon-phenyl bonds in triphenylcarbonium ion than in triphenylmethyl chloride; this bond strengthening was enough to offset the loss of a carbon-chlorine bond. An extension of this reasoning provided an explanation for the unusually small kinetic isotope effects, which were observed in SN1 substitution at carbon. (auth)

13412 MOLECULAR COMPOUNDS AND COMPLEXES. PART I. THE CRYSTAL STRUCTURE OF THE EQUIMOLAR MOLECULAR COMPLEX OF HEXABROMOBENZENE AND 1,2,4,5-TETRABROMOBENZENE. G. Gafner and F. H. Herbstein (Council for Scientific and Industrial Research, Pretoria). J. Chem. Soc.: 5290-5302(Dec. 1964).

An equimolar molecular complex formed by hexabromobenzene and 1,2,4,5-tetrabromobenzene was identified and its crystal structure determined by a partial three-dimensional analysis. The components appear to be bonded only by van der Waals interactions. The molecular arrangement is similar to that in hexabromobenzene with stacks of molecules in quasi-hexagonal array. Each stack contains only one molecular component and in this respect the packing differs from that in many polarization-bonded compounds where the stacks contain both components in alternating sequence. The molecules are both planar within the limits of error but d(Br ... Br) is less in hexabromobenzene (3.279 ± 0.008 Å) than in tetrabromobenzene (3.377 ± 0.004 Å) because in-plane splaying apart of bromine atoms is not possible in hexabromobenzene. The binary phase diagram and the conditions of formation of the molecular complex from solution were partly determined. The molecular complex decomposes in air at room temperature over a period of weeks by a topotactic reaction: tetrabromobenzene evaporates leaving behind hexabromobenzene crystallites. The hexabromobenzene crystallites on the surface are randomly oriented but those in the interior have the following orientation to the parent lattice: $[010]_{complex} \parallel [010]_{C_6Br_4}$ and $(001)_{complex} \parallel (101)_{C_6Br_4}$. (auth)

13413 ISOTOPE EFFECT IN CD_3OD SYNTHESIS. A. M. Watson (Universität, Munich). Naturwissenschaften, 51: 506(1964). (In German)

The presence of an isotope effect, α, in CD_3OD synthesis was investigated by a comparative study of the yield of CD_3OD and CH_3OH from the combination of CO and D_2 or H_2 in a device based on the Beersmans and Jungers apparatus. The reaction was followed at temperatures from 190 to 270°C and at pressures up to 4.5 atm. The temperature dependence of α was determined, and the effects causing this dependence were deduced. The α values determined were not effective for the comparison of the initial process velocities. It appeared that an inverse isotope effect was not probable. (J.S.R.)

13414 PLASTIC POLYVINYLTETRAHYDRONAPHTHALENE SCINTILLATORS WITH APPROXIMATELY 500 MILLI-MICRON LUMINOSITY MAXIMUM. N. M. Grachev, V. D. Bezuglyi, and A. S. Dykhanova (All-Union Scientific Research Inst. of Monocrystals, USSR). Pribory i Tekhn. Eksperim., No. 6, 61-2(Nov.-Dec. 1964). (In Russian)

Development of high-efficiency "longwave" polyvinyltetrahydronaphthalene scintillators is described. (tr-auth)

13415 HYDROGEN AND DEUTERIUM ATOM ABSTRACTION FROM O-METHYL HYDROXYLAMINE AND DEUTERATED O-METHYL HYDROXYLAMINE. KINETIC ISOTOPE EFFECT AND RELATIVE REACTIVITIES OF THE METHOXYL AND AMINO GROUPS. J. C. J. Thynne (Univ. of Edinburgh). Trans. Faraday Soc., 60: 2207-13(Dec. 1964).

The reactions of methyl radicals with O-methyl hydroxylamine and O-methyl hydroxylamine-d_2 were studied in order to determine the position and rate of hydrogen atom abstraction. Over the temperature range studied (70 to 190°C) the rate of abstraction from the amine group was considerably greater than from the methyl group. Substitution of D for H altered the reactivity by an amount predicted from consideration of zero-point energy differences. Arrhenius parameters (based on a value of $10^{13.34}$ mole^{-1} cm^3 sec^{-1} for the rate of recombination of methyl radicals) were determined for the reactions. Results for methylamine and methylhydroxylamine were compared. The influence of various groups and atoms on the reactivity of substrate molecules towards methyl radical attack is discussed. (auth)

13416 ISOTOPIC EXCHANGE OF HYDROGEN IN METHYL DERIVATIVES OF NITROUS HETEROCYCLES AND THEIR N-OXIDES. II. REACTIVITY AND ELECTRON STRUCTURE OF PICOLINE ISOMERS, THEIR N-OXIDES,

AND QUATERNARY SALTS. N. N. Zatsepina, I. F. Tupitsyn, and L. S. Efros. Zh. Obshch. Khim., 34: 4065-71 (Dec. 1964). (In Russian)

The hydrogen exchange reaction was examined for the case of α-picoline, its iodomethylate derivative, β-picoline, its N-oxide, γ-picoline, and various derivatives. The kinetic isotopic effect of the deuterium–tritium–protium exchange was also determined. The results indicated that the mobility of H in the CH_3 groups of the picoline isomers and their derivatives decreased in the following order: $\gamma > \alpha > \beta$ picoline, for the heterocycles themselves; $\alpha > \gamma > \beta$ for their N-oxides, and $\alpha > \gamma$ for the quaternary compounds. Passing from the main heterocyclic compound to the N-oxide and then to the quaternary compound results in acceleration of the exchange reaction. A close correlation was established between the kinetic characteristics of the D–exchange and nucleophilic substitution. Study of the kinetic isotopic effect revealed that the H–exchange reaction of the CH_3 groups may follow a coordinate or a gradual mechanism. It may result in the formation of a relatively stable carbanion (in the case of the iodomethylate of α and β-picoline) or of equilibrium concentrations of carbanions (in the case of α and γ-picolines and their N-oxides). The calculated energy of delocalization and the π-electron charges of the C atom next to the CH_3 group were used as an index of the reactivity. (TTT)

13417 ISOTOPIC EXCHANGE OF HYDROGEN IN METHYL DERIVATIVES OF NITROUS HETEROCYCLES AND THEIR N-OXIDES. III. REACTIVITY AND ELECTRON STRUCTURE OF THE α-METHYL SUBSTITUTED HETEROCYCLES AND IN THEIR N-OXIDES. N. N. Zatsepina, I. F. Tupitsyn, and L. S. Efros. Zh. Obshch. Khim., 34: 4072-80(Dec. 1964). (In Russian)

An attempt was made to determine the cause of the catalytic action of potassium ethylate and to uncover the relationship between the kinetic isotopic effect and various characteristics of the deuterium exchange reaction involving 3 isomers of benzoquinaldine, N-oxy-9-methylphenanthridine, and the N-oxide of β-naphthoquinaldine. Experiments were also carried out to determine the mobility of H in deuterium exchange reactions as a function of the ionization constant of the heterocyclic compounds and to relate it to the shifts in the high-resolution proton paramagnetic resonance spectra. The kinetic studies revealed the following order in the mobility of the H atoms of the methyl groups: for the main heterocyclic series, α-picoline < α-naphthoquinaldine < β-naphthoquinaldine < 9-methylphenanthridine; and for the N-oxide series, N-oxide of α-picoline < of β-naphthoquinaldine < of quinaldine < of 9-methyl phenanthridine. The rate constant of the D-exchange reaction not catalyzed by a strong alkali was found to be subjected to mutually opposite forces, the effect of the partial protonization of the N hetero atom causing a reduction of the energy of activation and that of the reduction of the exponent as the result of the low $C_2H_5O^-$ ions participating in the reaction. The superposition of these factors results in the reduction of the rate constant. The exchange reaction follows a carbanion type mechanism. Quantum chemical considerations agree well with the experimentally observed reactivity of the α-substituted heterocyclic compounds and their N-oxides and with proton magnetic resonance data. (TTT)

Radiation Chemistry

Refer also to abstracts 13402, 13405, 13545, 13764, and 13871.

13418 (AE-167) THE RADIO-THERMOLUMINESCENCE OF $CaSO_4$:Sm AND ITS USE IN DOSIMETRY. Begt Bjaerngard (Aktiebolaget Atomenergi, Stockholm). Dec. 1964. 31p. Dep.(mn).

The general properties of the thermoluminescence of $CaSO_4$:Sm have been investigated. The luminescent emission lies in the region 4,000–6,200 Å with narrow bands at 5,600 and 5,900 Å. The glow curve has the main peak at 400°C and a smaller one at 95°C. The fading of the thermoluminescence signal in the former peak is negligible at temperatures up to 200°C. The light yield of the 400°C emission is 0.3% at small exposures and increases to 1.5% at 10,000 R. Saturation occurs at about 30,000 R. The variation of the sensitivity is interpreted as being caused by a generation of new traps. It is concluded that $CaSO_4$:Sm provides a good basis for gamma dosimetry at high temperatures. It can be used up to somewhat above 200°C without corrections for the influence of the irradiation temperature. It may be used up to 300°C if the exposure times are restricted and corrections are applied. Because of the high readout temperature needed, the emission of incandescent light is a severe background component. The system described cannot be used for the determination of exposures less than about one roentgen. (auth)

13419 (AGN-TP-110) INVESTIGATIONS ON DECONTAMINATING FISSIOCHEMICALLY-PRODUCED HYDRAZINE. Robert H. Black (Aerojet-General Nucleonics, San Ramon, Calif.). [1963]. Contract [AT(04-3)-368]. 26p. (CONF-654-36). Dep.(mn); $2.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The principal radioactive fission products which were found in the filtered liquid ammonia-hydrazine product stream from the AGN in-reactor hydrazine loop were iodine, ruthenium, and tin isotopes. The iodine and ruthenium were found to be essentially non-volatile and were separated from the product by evaporating the hydrazine. Iodine was found to be subject to extraction from anhydrous hydrazine by ion exchange. Tin, with a relatively low fission yield, was decontaminated less effectively by evaporation than the other isotopes, and it did not have an affinity for the adsorbers or resins tested. It was concluded that a single evaporation would sufficiently reduce radiation levels to permit the product stream to leave a canyon-type remotely maintained processing plant and enter a plant with local shielding and direct maintenance. (auth)

13420 (CRC-1205) AN ANTHOLOGY OF EXPERIMENTAL TECHNIQUES IN RADIATION CHEMISTRY. Farhataziz and P. J. Dyne (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 1964. 28p. (AECL-2113). Dep.; $1.00(AECL).

Experimental details are presented for a variety of techniques of sample preparation and product analysis in radiation chemistry. (auth)

13421 (HW-81984(p.6.1-14)) GAS-COOLED REACTOR STUDIES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Results of studies concerning radioinduced gas-graphite reactions involving H_2, CH_4, N_2, and CO sealed in capsules are reported. Results are presented from reactor irradiations of capsules filled with graphite–H_2, graphite–H_2–CH_4, graphite–N_2, and graphite–H_2–CO. Results of H_2–CH_4 gamma irradiation are also reported. Reactions of graphite and water vapor at 750 to 900°C are reported, and the kinetics of CO_2–H_2 reactions are analyzed. (J.R.D.)

13422 (JUL-181-RC) DIE CHEMISCHEN FOLGEPRODUKTE DER $^{191}Ir(n,\gamma)^{192}Ir$-KERNREAKTION IN Ir-IV-HEXACHLOROKOMPLEXEN, IHRE IDENTIFIZIERUNG UND IHRE ROLLE BEI DER THERMISCHEN UND GAMMASTRAHLENAUSHEILUNG. (The Chemical Products of $^{191}Ir(n,\gamma)^{192}Ir$ Nuclear Reaction in Ir(IV) Hexachlorocomplexes, Their Identification, and Their Role in Thermal and Gamma Radiation Annealing). Rita Bell (Kernforschungsanlage. Institut fur Radiochemie, Julich, Germany). Sept. 1964. 95p. Dep.(mn).

Studies were made on neutron-irradiated crystalline $Na_2IrCl_6 \cdot 6H_2O$ with the purpose of identifying the individual recoil products with distinct iridium compounds. The behavior of the recoil products was investigated as accurately as possible under various chemical conditions. A separation method that permitted reproducible evaluation of all components of the recoil system was developed. With the help of the results obtained on $Na_2IrCl_6 \cdot 6H_2O$, the studies

were extended to the neutron-irradiated Ir hexachloro complexes of K and NH_4. Parallels were found in the behavior of their recoil products with that of the Na complex. The results of the thermal annealing at 120°C and γ radiation annealing in the neutron-irradiated Na complex were investigated. The role of the individual reaction products of (n,γ) processes on Ir on the annealing was discussed. (J.S.R.)

13423 (KFK-243) ZUR Co-60-γ-RADIOLYSE VON ISOPROPANOL UND SEINEN MISCHUNGEN. ENERGIELEITUNG IM SYSTEM BENZOL-BENZOPHENON-ISOPROPANOL. (Co^{60} γ Radiolysis of Isopropanol and Its Mixtures. Energy Transfer in the System Benzene-Benzophenone-Isopropanol). Clemens von Sonntag (Kernforschungszentrum. Institut fur Radiochemie, Karlsruhe, Germany). July 1964. 147p. Dep.(mn).

In the γ radiolysis of isopropanol, acetone, acetaldehyde, pinakone, butandiol-(2,3), and ethanol are formed in addition to other products. The G values of these products were determined. The radiochemical yields of acetone, acetaldehyde, pinakone, and butandiol were investigated in mixtures of isopropanol with benzene, naphthalene, benzophenon, p-hydroxybenzophenon, thiophenol, benzylalcohol, triphenyl methane, water, acetone, cyclohexane, and sulfuric acid. In the γ irradiation of isopropanol–benzophenon mixtures, benzpinakons were formed, and various substituted benzpinakons were prepared. The 4,4′-dihydroxybenzpinakon could be prepared in no other way. It was concluded that the principal part of the acetone formed in the radiolysis of isopropanol arose from a disproportionation of the 2-hydroxy-propyl-(2) radical. In the benzene–benzphenon–isopropanol system, energy transfer from the benzene to the benzphenon occurred. The benzphenon was dehydrated from its excited state. From the increased acetone yield it followed that 12% of the radiation energy absorbed by the benzene was transferred to the benzphenon. With a mass spectrometer, it was shown that for the primary processes in the γ radiolysis ion-molecule reactions must be taken into consideration. The radiochemical decomposition of the isopropanol was explained by the reactions of the isopropanol radical cations and the solvated electrons. (tr-auth)

13424 (NYO-2047-30) INVESTIGATIONS OF RADIATION EFFECTS IN METAL OXIDES AND AZIDES BY ELECTRON SPIN RESONANCE. Progress Report, February 1, 1964–January 31, 1965. Ralph H. Bartram and Otis R. Gilliam (Connecticut. Univ., Storrs). Jan. 31, 1965. Contract AT(30-1)-2047. 132p. Dep.(mn); $4.00 (cy), 3(mn) OTS.

An activation energy of 0.7 ev was measured for the process interstitial O^+ to interstitial O^0 in reactor-irradiated α-Al_2O_3. A new center was discovered in electron-irradiated KHF_2 and has been identified as an F_2^- molecule ion in an anion site. A similar center was discovered in $NaHF_2$. The investigation of threshold energy in electron-irradiated Al_2O_3 is continuing. The zero-field splitting of interstitial O^- in Al_2O_3 was calculated and found to agree with the measured value when allowance is made for lattice distortion. Refined calculations of the F center and F′ center in Al_2O_3 established a correlation of the F center with the 5.45 ev band. The energy of the F′ band in alkali halides was calculated in agreement with experiment. Progress was made on the calculation of energy levels for $(AlO)^{3-}$ in Al_2O_3. (D.L.C.)

13425 (NYO-2383-12) STUDIES OF THE RADIATION CHEMISTRY OF ORGANIC COMPOUNDS. Progress Report, February 1, 1964–January 31, 1965. Norman N. Lichtin (Boston Univ.). Feb. 5, 1965. Contract AT(30-1)-2383. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Progress of research activities of Boston University in the field of radiation chemistry of organic compounds is reported. Information is included on: reaction of active nitrogen with carbon-14 labeled propylenes, effects of water and sulfuric acid on the yield of hydrogen peroxide from gamma-radiolysis of aerated methanol, development of vapor chromatographic methods of determining the products of radiolysis of methanol, spectrophotometric detection of an impurity in methanol, and optical rotatory changes associated with gamma-radiolysis of 2-methylbutanol. (N.W.R.)

13426 (PAN-547/XVII) MECHANIZM I KINETYKA INICJOWANEGO NAPROMIENIENIEM GAMMA I IMPULSOWYM NAPROMIENIENIEM ELEKTRONAMI LANCUCHOWEGO UTLENIENIA DWUWARTOSCIOWEGO ZELAZA W KWASNYCH, NAPOWIETRZONYCH ROZTWORACH WODNYCH ZAWIERAJACYCH ALKOHOL ETYLOWY. (Mechanism and Kinetics of γ- and Pulse Electron Induced Oxidation of Divalent Iron in Acid, Air Saturated Ethyl Containing Aqueous Solutions). Lech Stolarczyk (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1964. 102p. Dep.

The final radiation yield and the kinetics of the oxidation of iron(II) in acid, air saturated, aqueous solutions containing ethyl alcohol were studied after pulse electron irradiation and after gamma irradiation. The analysis of the results was used to elucidate the mechanisms and kinetics of the processes involved. (auth)

13427 CATHODOLUMINESCENCE OF THIN FILMS CONTAINING RARE-EARTH OXIDES. W. W. Hansen and R. E. Myers (Stanford Research Inst., Menlo Park, Calif.). Appl. Phys. Letters, 6: 58-9(Feb. 1, 1965).

The luminescence of thin films of Al_2O_3 and Y_2O_3 and of Gd_2O_3 and Y_2O_3 doped with rare-earth oxides was studied using an electron beam for excitation. Relative efficiencies were determined, and the rise and decay times of luminescence were measured. Al_2O_3 and Y_2O_3 powders were also studied. (D.C.W.)

13428 THE RADIOLYSIS OF ETHANOL. III. LIQUID PHASE. J. J. J. Myron and G. R. Freeman (Univ. of Alberta, Edmonton). Can. J. Chem., 43: 381-94(Feb. 1965).

The G values of the major products of the γ radiolysis of liquid ethanol at a dose of 2×10^{20} ev/g were: hydrogen, 4.2; acetaldehyde, 1.9; 2,3-butanediol, 2.2; $G(-C_2H_5OH) = 7.5$. At progressively lower doses $G(H_2)$ increased to a maximum of 5.0. The yield of water, $G(H_2O) = 0.5$, was equal to the sum of the yields of the C_2 fragments found in the other products. The approximate yields of three kinetically distinguishable sources of hydrogen were found to be $G(e^-_{solv}$, free ion) = 0.9, G(H) = 2.7 and G(unscavengeable H_2) = 1.5. The half life of solvated electrons with respect to reactions such as $e^-_{solv} \rightarrow C_2H_5O^- + H$ is 3 μs. Both 1,3-pentadiene and benzene inhibit hydrogen and glycol formation but neither affect the high dose yield of acetaldehyde. Pentadiene reacts with H atoms and other radicals and possibly also with e^-_{solv}. Benzene appears to inhibit hydrogen and glycol formation mainly by an unidentified activation transfer process. (auth)

13429 MODIFYING OF PLASTICS VIA RADIATION GRAFTING. Max Mozisek and Leo Klimanek (Research Inst. of Rubber and Plastic Tech., Gottwaldov, Czechoslovakia). Chem. Listy, 58: 1396-1429(1964). (In Czech.)

Basic questions on the structure and kinetics of formation of grafted compounds are considered. Economic aspects of radiation grafting are discussed; surface properties changes by grafting are evaluated. Grafting and crosslinking of polyvinyl chloride by multifunctional monomers improved its resistance against high temperatures and solvents. Grafting of polyolefins and synthetic rubbers is discussed. (120 references) (OTS)

13430 THE RADIOLYSIS OF LIQUID HEXANE. Tino Gaeumann (Technische Hochschule, Zurich). Chimia (Aarau), 18: 345-74(Nov. 16, 1964). (In German)

The radiolysis of liquid hexane is used as an example of the questions resulting from such studies and the data that can be expected. It is shown that a fraction of the radioinduced reactions can be assigned to radical reactions that lead to very specific fragmentation probabilities. (J.S.R.)

13431 EFFECTS OF RADIOACTIVITY ON CELLULOSE. I. Emamura. Genshiryoku Kogyo, 9: No. 1, 62-8(1963). (In Japanese)

When cellulose was gamma irradiated, the extent of rupture of the molecules was directly proportional to the irradiation intensity. Results with neutron, gamma, and cathode rays showed that the extent of the damage was independent of the type of source. In fibers of wood cellulose pulp gamma irradiated to 10^6 R, crosslinking appeared first as a result of mechanical blows. The degree of polymerization was about 30. This is explained by localization of the damage. Mass-spectrometer analysis of the gas formed on gamma irradiation of a cellulose film to 1.1×10^6 and 7.1×10^7 R showed chiefly H_2. The residue was depleted in hydrogen. In the second stage of the irradiation, aldehyde, ketone, and carboxyl groups appeared with subsequent formation of formyl, acetyl, and arabinyl groups. (TCO)

13432 RADIATION POLYMERIZATION OF PHENETHYLENE OXIDE. I. Tabata. Genshiryoku Kogyo, 10: No. 1, 58-62(1964). (In Japanese)

According to earlier theories, radiation polymerization with ring breakage takes place only in the solid phase by an ionic reaction. With styrene oxide the reaction may take place in either the solid or liquid phase. Carefully purified monomer samples were electron or gamma irradiated at temperatures from −200 to +150°C. An induction period was not observed with gamma irradiation, but was with electron irradiation in the liquid phase. Below −95°C there was none in the solid phase. From −78 to −128°C there was a tendency towards saturation, and from −158 to −196°C the effect was accelerated. The activation energy was greater for liquid than for solid-phase polymerization. Liquid-phase polymerization was shown to be a polymerization of free groups with ring breakage. The activation energy in gamma irradiation was approximately the same as that of a typical free group and in electron irradiation was very high. Temperature had considerable effect on free-group polymerization. Copolymerization of styrene oxide and propylene oxide is briefly described. (C.E.S.)

13433 RADIOACTIVITY MEASUREMENTS WITH NITRIC OXIDE DOSIMETER. T. Takaya and I. Sekimiti. Genshiryoku Kogyo, 9: No. 2, 60-4(1963). (In Japanese)

Studies showed that radiation may be measured by the pressure developed in a glass tube of NO_2 as N_2 and O_2 are formed by radiolysis. The $N_2 + O_2$ pressure was found to vary linearly with radiation (^{60}Co) doses between 10^6 and 10^9 R. The NO_2 was contained in a 5-mm-dia by 50-mm-long tube, and pressure measurements were simplified by submerging the part of the tube containing a thermistor in liquid nitrogen. For dose rates from 8.4 × 103 to 1.4×10^6 R/hr such a dosimeter works regardless of the dose. From 0 to 50°C the dosimeter operation is independent of temperature. The measurement error is ±10%. The pressure remains constant for 15 days after the irradiation. The advantage of this dosimeter is the possibility of using it to measure doses as high as 10^9 R. (TCO)

13434 THERMAL DECOMPOSITION OF IRRADIATED MANGANESE CARBONATE. S. R. Mohanty and M. N. Ray (Banaras Hindu Univ., Varanasi, India). Indian J. Chem., 3: 37(Jan. 1965).

The thermal decomposition of manganese carbonate, unirradiated and irradiated with 25 Mrad of ^{60}Co γ rays, was investigated at different temperatures in the range from 170 to 290°C. It was found that irradiation enhances the rate of decomposition. (auth)

13435 COMPARISON OF GAMMA AND ULTRAVIOLET RADIATION EFFECTS IN POLYMETHYL METHACRYLATE AT HIGHER TEMPERATURES. A. Charlesby and N. Moore (Royal Military Coll., of Science, Swindon, Eng.). Intern. J. Appl. Radiation Isotopes, 15: 703-8(Dec. 1964).

Measurements of $G_{(scission)}$ values for γ irradiation of PMMA at temperatures up to 180°C show a limiting value of 10 ± 1, with an activation energy of 0.98 kcal/mole, and no significant intensity dependence. Depolymerization at the higher temperatures is far smaller than with uv radiation and this is interpreted as showing a difference between the two forms of radiation damage. Ultraviolet radiation is selectively absorbed at chain ends which initiate depolymerization. The main chain scissions produced by γ radiation (and to a lesser extent by uv) are far less effective in the initiation of depolymerization. (auth)

13436 COMMERCIAL 1 mm CLEAR PERSPEX AS A GAMMA-RADIATION DOSIMETER. G. Davidson and H. C. Sutton. (Ethicon Ltd., Edinburgh). Intern. J. Appl. Radiation Isotopes, 15: 741-5(Dec. 1964).

The use of commercial clear Perspex as a radiation dosimeter in a ^{60}Co sterilizing plant is described. The method is satisfactory in the 2-3 M Rad range and offers certain advantages over other dosimeters. (auth)

13437 THE RADIATION POLYMERIZATION OF ISOBUTYLENE AND STYRENE. V. Stannett, F. C. Bahstetter, J. A. Meyer, and M. Szwarc (State Univ. Coll. of Forestry, Syracuse, N. Y.). Intern. J. Appl. Radiation Isotopes, 15: 747-57(Dec. 1964).

The radioinduced polymerizations of isobutylene and styrene were both studied in the liquid phase at −78.5°C. An ionic mechanism is believed to be operative with both monomers. In spite of extreme precautions of drying and purification irreproducible results were obtained. However, a number of interesting conclusions were drawn from the results. In the case of isobutylene, extremely rigorous drying conditions gave far higher G(conversion) values than previously reported. The polymer produced was found to be degraded by the radiation and G(initiation) values were not therefore obtainable. However, the polymers from experiments with very low G(conversion) values were found to have also lower molecular weights and the irreproducibility appeared due to variations in the chain length rather than the initiation rate. In the case of styrene in methylene chloride solution, the polymerization-dose curves were steeper initially and then leveled off to a slower, steadier rate. The second slope was comparatively insensitive to moisture. The G(conversion) values varied considerably more than the G(initiation) values, and the wide variations in polymerization rates seemed to be mainly due to changes in the degree of polymerization rather than in the initiation rate. The effect of the addition of soluble organic compounds of high electron affinity was also studied; in general, the rates and the molecular weights were found to be somewhat reduced and in no case were any substantial increases found. (auth)

13438 GAMMA IRRADIATION, IN THE SOLID STATE, OF OLIGOPEPTIDES AND AMINO ACIDS PROTECTED IN THE N AND C TERMINAL GROUPS. R. Badiello and A. Breccia (Universita, Bologna). Intern. J. Appl. Radiation Isotopes, 15: 763-5(Dec. 1964).

Studies were made on the radiolysis of oligopeptides and radiation effects on decarboxylation of amino acids in the solid state with protected N and C terminal groups. Chromatographic, polarographic, elementary, and functional group microanalyses made on the irradiated oligopeptides showed that the amino, aldehyde, carbonylic, and enolic groups did not arise in more than 10^{-5} concentration. The average yield of decarboxylation was 0.4% and G_{CO_2} was 0.10-0.30. Masking the terminal −COOH and $-NH_2$ groups gave the nitrogen compounds more resistance to radiation damage. (P.C.H.)

13439 NEUTRON TRANSMUTATION DOPING. D. S. Ballantine, comp. (Brookhaven National Lab., Upton, N. Y.). Isotopes Radiation Technol., 2: 149-57(Winter 1964-65).

Principles of transmutation doping are reviewed, equations developed, and economics of the process are discussed. The fabrication of operational electronic devices by this method is described. The thermal neutrons transmute some semiconductor atoms into electronically active impurities. Results demonstrated not only that the technique is practical but also that the calculated properties agree well with experimentally measured values. A compensation doping diagram and the relation between geometric shielding effectiveness and initial concentration of impurities are shown. Design and fabrication of radiation

capsules for the process are described. Reactor irradiation requirements are listed, and experimental methods are outlined. (M.C.G.)

13440 ENERGY MIGRATION IN GAMMA-IRRADIATED CRYSTALLINE SOLIDS AT 77°K. W. Van Dusen, Jr. and F. K. Truby (Sandia Lab., Albuquerque, N. Mex.). J. Am. Chem. Soc., 87: 188-90(Jan. 20, 1965).

The γ radiolysis of 0.2M methyl bromide in cyclohexane was examined at 77°K. The results are consistent with an interpretation of dissociative electron capture by the solute and an ion-molecule reaction between matrix molecules. (auth)

13441 MODERATOR EFFECTS ON RECOIL TRITIUM REACTIONS WITH METHYL AND METHYL-d_3 FLUORIDES. E. K. C. Lee, George Miller, and F. S. Rowland (Univ. of Kansas, Lawrence). J. Am. Chem. Soc., 87: 190-9(Jan. 20, 1965).

The isotopic variations between CH_3F and CD_3F in recoil tritium reactions were investigated for the O_2-scavenged compounds, and for O_2- and I_2-scavenged mixtures with a large excess of ^4He. The relative yields of HT : CH_2TF : CH_3T from CH_3F were 185 : 100 : 33, and of DT : CD_2TF : CD_3T from CD_3F 187 : 100 : 31, but the absolute yields of all products from CH_3F were higher than from CD_3F. The ratios of CH_2TF/CH_3T and CD_2TF/CD_3T were only slightly affected by the presence of ^4He moderator, indicating that the reactions forming the compounds occur at about the same average kinetic energy for the tritium. The isotope effect in substitution for H or D favored H replacement by 1.27 ± 0.04 in a large excess of ^4He. This fact implies that the primary source of the isotopic variation must lie in probability integral isotope effects, i.e., a larger probability for reaction per collison with CH_3F than for CD_3F and/or a larger range of tritium energy within which reaction is possible. The average energy losses in nonbonding collisions were greater for tritium atoms in CH_3F than in CD_3F ($\alpha_{CH_3F}/\alpha_{CD_3F} = 1.23 \pm 0.08$). (auth)

13442 THE POLYMERIZATION OF CYCLOPENTADIENE BY FREE IONS. DETERMINATION OF THE PROPAGATION RATE CONSTANT. Michael A. Bonin, William R. Busler, and Ffrancon Williams (Univ. of Tennessee, Knoxville). J. Am. Chem. Soc., 87: 199-207(Jan. 20, 1965). (TID-21096)

The technique of radioinduced ionic polymerization at low temperature was used to determine the propagation rate constant, $k_p = 5.8 \times 10^{\pm 1}\ M^{-1}\ sec^{-1}$, for the polymerization of cyclopentadiene by free ions at $-78°C$. In this method, ammonia was employed as a terminating agent to obtain the ratio of rate constants, k_t/k_p, for termination to propagation, while the value of k_t was calculated from the Smoluchowski-Debye theory for encounter-controlled reactions. The significance of high k_p values for polymerization by free ions is discussed with reference to conventional ionic polymerization. (auth)

13443 CHEMISTRY OF RADIATION CROSSLINKING OF BRANCHED FLUOROCARBON RESINS. E. R. Lovejoy, M. I. Bro, and G. H. Bowers (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). J. Appl. Polymer Sci., 9: 401-10(Feb. 1965).

A number of commercial and experimental fluoropolymers were subjected to ionizing radiation at elevated temperatures and the changes in melt viscosity were measured as an indication of the degree of crosslinking or degradation that occurred. Polytetrafluoroethylene, polychlorotrifluoroethylene, and polyhexafluoropropylene, and a copolymer of hexafluoropropylene with perfluoroheptene-1 decreased in melt viscosity when irradiated at 200 to 250°C, while copolymers of tetrafluoroethylene with hexafluoropropylene, octafluorobutylene, or perfluoroheptene-1 increased in melt viscosity, indicating crosslinking. The results suggested that the reaction of species of the type $\sim\!(\sim\!CF_2)_2CX - (CF_2)_n\cdot$ (where X is F or CF_3) with $\sim\!CF_2 - CF_2\cdot$ is the important one leading to crosslinking. (auth)

13444 EFFECTS OF γ-IRRADIATION ON THE LOSS PROPERTIES OF DIELECTRICS IN VACUUM. J. K. Miles and D. M. Newell (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Appl. Polymer Sci., 9: 483-94(Feb. 1965).

Dielectric constant and dissipation factor of six types of dielectrics were measured during irradiation using a ^{60}Co source. Tests were made at seven frequencies ranging from 100 cycles/sec to 100 kcycles/sec by use of the Schering bridge technique. Polystyrene and polyethylene exhibited no change in loss properties when γ-irradiated to doses as high as 7.7×10^7 and 3.5×10^7 r, respectively. Polymethyl methacrylate decreased slightly in dielectric constant and was essentially unchanged in dissipation factor after 5.7×10^7 r. Tetrafluoroethylene underwent the most drastic changes. At a very low dose (10^6 r) the dissipation factor increased three orders of magnitude (at 100 cycles/sec) and one order of magnitude (at 100 kcycles/sec). After peaking, the loss factor decreased slowly. After removal of the source, the loss factor decreased more; then increased rapidly upon admission of air. Both this and the original increase in dissipation factor are indicative of a dipole with a long relaxation time, in which oxygen plays a role. Hexafluoropropylene teflon increased somewhat less than tetrafluoroethylene, and the peak was not reached until a dose of 3×10^7 r. Very little effect was produced by the admission of air after irradiation. Dielectric constant decreased with radiation dose. The dissipation factor and dielectric constant of Rayolin N decreased with dose, until a plateau was reached. Very little effect was seen after irradiation, even upon the admission of air. The changes which took place during the radiation period were, as in the case of the other materials, greater at the lower frequencies than they were at the higher frequencies. (auth)

13445 PARAMAGNETIC ABSORPTION OF SINGLE CRYSTALS OF SUCCINIC ACID IRRADIATED AT LOW TEMPERATURE. Harold C. Box, Harold G. Freund, and Kenneth T. Lilga (Roswell Park Memorial Inst., Buffalo). J. Chem. Phys., 42: 1471-4(Mar. 1, 1965).

Electron spin resonance absorption was observed in single crystals of $(-CH_2-COOH)_2$, $(-CH_2-COOD)_2$, and $(-CH_2-{}^{13}COOH)_2$ irradiated at 77°K. The principal paramagnetic species observed at low temperature had an unpaired electron in a $2p\pi$ orbital on the carbon atom of the carboxyl group. It was probably ionized succinic acid with the oxygen of the carboxyl group carrying a negative charge. (auth)

13446 ON THE USE OF DOUBLE-IRRADIATION METHODS FOR THE ASSIGNMENT OF HIGH-RESOLUTION NMR SPECTRA WITH REPEATED SPACINGS. Ragnar A. Hoffman (Uppsala Univ.), Bo Gestblom, Soeren Rodmar, and Sture Forsen. J. Chem. Phys., 42: 1695-1708(Mar. 1, 1965).

An analysis of double-resonance experiments on pseudo-AX systems (i.e., pairs of doublets, the four transitions of which form a closed polygon in the energy level diagram) based on the formalism of Freeman and Anderson, is presented. Expressions are given for the transition frequencies and the transition probabilities in the general case. It is demonstrated that double irradiation may lead to the collapse of a repeated interval under comparatively general conditions and that double irradiation may alternatively lead to enlargement of the doublet splitting in spin systems that are not ideal for "decoupling" experiments. The collapse or the enlargement of (repeated) doublet splittings may be used to establish the correct level arrangement in a general spin system. As illustrative applications of these methods, the ABX spectra of 5-methylthio-2-thiophenethiol and trans-cinnamaldehyde were studied experimentally. In 5-methylthio-2-thiophenethiol selective "decoupling" and selective enlargement as well as general double irradiation experiments were performed and it was found that the sign of the side-chain coupling J_{SH-3} is opposite to that of the ring-coupling constant J_{34}. The implications of this result with regard to the mechanism of long-range thiol proton spin couplings are indicated. In trans-cinnamaldehyde selective enlargement of an unresolved repeated spacing was produced in order to corroborate the earlier result that the two vicinal couplings in the side chain carry the same sign. (auth)

13447 THE PHOTOCHEMICAL DECOMPOSITION OF RUBIDIUM AND CAESIUM AZIDES. P. W. M. Jacobs and A. R. Tariq Kureishy (Imperial Coll. of Science and Tech., London). J. Chem. Soc.: 4723-30(Dec. 1964).

Rubidium azide resembles potassium azide in that the rate of photolysis at first decreases, passes through a minimum, and then increases, finally attaining a constant value. The rate of photolysis of cesium azide decreases, becomes constant for a brief period, and then decreases again before becoming constant. It is shown that the overall rate curves for these reactions can result from the superposition of three curves, one for each reaction mechanism; two of these processes have been described previously. The third is considered to involve the reaction of excitons and excited azide ions at metal nuclei and to produce N_4^- ions. The subsequent thermal decomposition of these ions is responsible for the dark reaction that occurs on switching off the lamp. A photochemical reaction between nitrogen gas and rubidium metal was noted. (auth)

13448 OXIDATION OF TETRAFLUOROETHYLENE BY MOLECULAR OXYGEN. V. Caglioti, A. Delle Site, M. Lenzi, and A. Mele (CNEN, Rome and Universita, Rome). J. Chem. Soc.: 5430-3(Dec. 1964).

The main products of the oxidation of tetrafluoroethylene induced by heat, ultraviolet light, and ionizing radiation were found to be carbonyl fluoride, tetrafluoroethylene oxide, hexafluorocyclopropane, and a liquid polymeric peroxide. The reactions were carried out by a static method in the gas phase. (auth)

13449 STUDY OF THE REACTION OF METHANE WITH IODINE-125 FORMED BY ELECTRON CAPTURE OF XENON-125. Francis Schroth and Jean-Pierre Adloff (Centre de Recherches Nucleaires, Strasbourg). J. Chim. Phys., 61: 1373-80(Oct. 1964). (In French)

In the gaseous phase, (58 ± 6)% of the atoms from the electron capture of ^{125}Xe react with methane to form methyl iodide $CH_3\,^{125}I$. The yield of the radiosynthesis was determined in the presence of rare gases. Neon and argon were without effect, whereas xenon and krypton lowered the yield to (18 ± 2)% for a molar fraction close to unity. It was concluded that 40% of the ^{125}I atoms participate in the reaction in the ionic state $I^+(^1S_2)$ and 18% in the form of strongly excited iodine atoms or the ions $I^+(^3P_0)$ or $I^+(^3P_1)$. (tr-auth)

13450 CATALYSIS OF RADIOLYTIC OXIDATIONS IN AQUEOUS SOLUTION BY OSMIUM TETROXIDE. J.-C. Dran and M. Haissinsky (Universite, Paris). J. Chim. Phys., 61: 1421-7(Oct. 1964). (In French)

Osmium tetroxide is not altered in acid solution under the influence of γ rays from radiocobalt, but its presence modifies the measured yield of molecular products from decomposition of water, H_2 and H_2O_2. It accelerated the radiolytic oxidation of several solutes in the presence of oxygen because of its sensitizing effect on oxidation by H_2O_2. In the case of Te^{4+} in acid solution, the addition of very small quantities (7×10^{-6} M) increased $G(Te^{4+})$ from 3.2 to 6.0. OsO_4 suppressed, under certain conditions, the prolonged effect observed after irradiation of solutions of Pt^{2+} or arsenite with γ rays. The oxidation yield was then equal to the total yield measured in its absence, after the prolonged effect. In the case of phosphites, the catalyst exercised a sensitizing effect on the oxidation at pH less than 2. It had a protective effect at higher pH by leading eventually to suppression of the chain reaction, which characterizes the radiolytic oxidation of phosphites. A general mechanism of these phenomena is proposed. The velocity constant of the reaction $OsO_4 + HO_2$ was evaluated as 5.7×10^5 liter mol^{-1} sec^{-1}. (tr-auth)

13451 EFFECT OF COBALT-60 GAMMA RADIATION ON THE OXYGENATED HETEROCYCLES: DIOXANE, FURANE, AND TETRAHYDROFURAN. Yvan Llabador and Jean-Pierre Adloff (Centre de Recherches Nucleaires, Strasbourg). J. Chim. Phys., 61: 1467-8(Oct. 1964). (In French)

In order to determine the effect of structural factors on the mechanism of radiolytic decomposition of oxygenated heterocyclic compounds, furan and tetrahydrofuran were exposed to γ radiation under the same conditions as were used previously for dioxane. The initial radiochemical yields of the radiolytic products were determined and tabulated. For each of the compounds the balance of the radiolytic products whose formation results from the opening of the cycle was established. The disappearance yield of the irradiated compounds by opening of the cycle were 1.47 for dioxane, 2.02 for tetrahydrofuran, and 0.54 for furan. The tetrahydrofuran molecule was the most unstable and the furan structure was the most stable. (J.S.R.)

13452 THE BEHAVIOUR OF RECOIL Cr^{51} IN CHROMATES DEPOSITED ON MgO. S. R. Veljkovic, S. M. Milenkovic, and M. R. Ratkovic (Univ. of Belgrade). J. Inorg. Nucl. Chem., 27: 266-9(Jan. 1965).

Possible interactions of ^{51}Cr recoil atoms with the matrix were studied in a mixture of chromates and MgO. The target material was prepared by evaporating the K_2CrO_4 solution on MgO powder with constant mixing. The neutron irradiations were carried out for one day with a neutron flux of 3×10^{13} n/cm^2 sec. An analysis of the recoil products was made by dissolving the targets in 0.5N HCl and subsequently separating Cr^{3+} on an acid Al_2O_3 column. The activity of ^{51}Cr(III) was determined by scintillation counting of column wash solution. Chromate ion was determined from the difference in total ^{51}Cr activity. The distribution of recoil ^{51}Cr in the targets showed a preponderance of Cr^{3+} ion for both chromate on MgO and Cr^{3+} on MgO. (M.C.G.)

13453 THE RADIATION-INDUCED DECOMPOSITION OF THE ALKALI AND ALKALINE EARTH PERCHLORATES. I. PRODUCT YIELDS AND STOICHIOMETRY. L. A. Prince and E. R. Johnson (Stevens Inst. of Tech., Hoboken, N. J.). J. Phys. Chem., 69: 359-77(Feb. 1965).

The radioinduced decomposition of the alkali and alkaline earth perchlorates was studied. ClO_3^-, ClO_2^-, ClO_2, ClO^-, Cl^-, O_2, and metal oxide (or superoxide), and possibly some ClO_3, were products. Good stoichiometry was obtained. The order of decreasing $G^0_{ClO_4^-}$ was Cs > Rb > Mg > Sr > Na > Ca > K > Li > Ba. (auth)

13454 THE RADIATION-INDUCED DECOMPOSITION OF THE ALKALI AND ALKALINE EARTH PERCHLORATES. II. MECHANISM OF THE DECOMPOSITION. L. A. Prince and E. R. Johnson (Stevens Inst. of Tech., Hoboken, N. J.). J. Phys. Chem., 69: 377-84(Feb. 1965).

The mechanism of the radioinduced decomposition of the alkaline earth perchlorates is discussed. Evidence is presented to show that ClO_3^-, Cl^-, ClO_2^-, ClO_2, and oxygen are the primary products and that ClO^- is not, its appearance being concomitant with a decrease in the yield of ClO_2 and ClO_2^-. The yields of ($ClO_2 + ClO_2^-$) and Cl^- are related and appeared to originate from a competitive primary reaction. Data are presented on the thermal decomposition of the products in the irradiated crystals. It is shown that ClO_2^- and ClO^- thermally decompose to yield Cl^-, whereas ClO_2 undergoes a neutralization reaction. (auth)

13455 GENERATION OF CATALYTIC ACTIVITY IN SILICA GEL BY IONIZING RADIATION. C. Barter and C. D. Wagner (Shell Development Co., Emeryville, Calif.). J. Phys. Chem., 69: 491-4(Feb. 1965).

It was previously reported that acid centers are generated in silica gel by the action of ionizing radiation, in vacuo. These centers persist in the gel, in the absence of radiation, but are thermally sensitive. At 25°C they disappear with a half-time of a few hours, as shown by the loss of acid titer and activity for isobutylene polymerization. Further study of irradiated silica gel disclosed that radiation generates at least two other types of chemically active centers. These are stable at more elevated temperatures and are active for butene interconversions and for the conversion of cyclopropane to propylene. (auth)

13456 VACUUM ULTRAVIOLET PHOTOCHEMISTRY. VIII. PROPYLENE. D. A. Becker, H. Okabe, and J. R. McNesby (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 69: 538-46(Feb. 1965).

The direct photolysis of propylene was carried out below (at 1470 Å) and above (at 1236 Å) the ionization potential. Major products were acetylene, ethylene, hydrogen, methane, ethane, propane, propyne, allene, isobutane, and C_4-unsaturated hydrocarbons. No appreciable energy dependence was observed in the distribution of products. Isotopic analysis of photolytic products, hydrogen, methane, ethane, and ethylene, from the mixture of $C_3H_6-C_3D_6$ and from CH_3CHCD_2, was made to obtain information on the reaction mechanism. The isotopic composition of the ethylene product, which is considered to be at least partially produced at 1236 Å from the ion-molecule reaction, $C_3H_6^+ + C_3H_6 \rightarrow C_4H_6^+ + C_2H_4$, was not sufficiently defined to confirm the occurrence of this reaction. The following primary processes are postulated to reasonably explain the isotopic distribution of products: $C_3H_6 \rightarrow CH_3 + H + C_2H_2$; $C_3H_6 \rightarrow CH_4 + C_2H_2$; $C_3H_6 \rightarrow H_2 + C_3H_4$; $C_3H_6 \rightarrow H + C_3H_5$; $C_3H_6 \rightarrow CH_2 + C_2H_4$; and $C_3H_6 \rightarrow CH_3 + C_2H_3$. (auth)

13457 γ-RADIATION-INDUCED ISOMERIZATION OF CYCLOHEXANONE TO 5-HEXENAL IN THE LIQUID PHASE. Ajit Singh and Gordon R. Freeman (Univ. of Alberta, Edmonton, Can.). J. Phys. Chem., 69: 666-8 (Feb. 1965).

When liquid cyclohexanone was irradiated with ^{60}Co gamma rays, the compound isomerized to 5-hexanal with a yield of 0.85 G unit. Evidence is presented, which indicates that the lowest triplet state of cyclohexanone is a precursor of or a reactant in the isomerization reaction. The effects of oxygen, benzene, and 2,3-dimethyl-1,3-butadiene on the reaction were determined. Studies indicated either a concerted or a diradical intermediate mechanism for the isomerization of cyclohexanone to 5-hexanal. (M.C.G.)

13458 RADIOLYSIS OF CYANOGEN–CYCLOHEXANE MIXTURES. J. A. Knight, R. A. Stokes, and David Bowen (Georgia Inst. of Tech., Atlanta). J. Phys. Chem., 69: 678-81(Feb. 1965). (TID-20679)

The irradiation of mixtures of cyanogen and cyclohexane is described. In the presence of cyanogen, yields of hydrogen, cyclohexene, and dicyclohexyl from radiolysis of cyclohexane decreased with increasing concentrations of cyanogen. Cyclohexyl cyanide was formed with $G \sim 25$ under optimum conditions, which indicated a chain process. (M.C.G.)

13459 ISOTOPE EFFECTS IN THE RADIOLYSIS AND PHOTOLYSIS OF H_2O-D_2O MIXTURES. M. Anbar and D. Meyerstein (Stanford Univ., Calif. and Soreq Research Establishment, Nahal Soreq, Israel). J. Phys. Chem., 69: 698-700(Feb. 1965).

Isotope effects on the formation of hydrogen atoms from neutral and acid H_2O-D_2O solutions were studied. This isotope effect was also compared with the effect in the photolysis of acid aqueous iodide solutions. In a 1:1 H_2O:D_2O mixture, the isotope effect on the formation of molecular hydrogen was equal to the H/D ratio in the evolved gas, and it was lower in neutral solutions than in acid solutions. The results proved that the atomic hydrogen is formed by two different mechanisms. (M.C.G.)

13460 COLORATION OF IRRADIATED SODIUM-SILICATE GLASS CONTAINING IMPURITIES. Hiroshi Sasakura, Nozomu Takeuchi, Masakazu Miyagi, Hiromi Matsuda, Hisao Kami, and Torao Nobusawa (Industrial Research Inst., Osaka Prefecture, Osaka). Japan. J. Appl. Phys., 3: 767-72(Dec. 1964).

It was found that Au-glass becomes black immediately after irradiation. It becomes transparent after a subsequent heat treatment at 200°C, and becomes red after a subsequent heat treatment at above 500°C. These changes are attributed to the formation of F-centers, annihilation of F-centers, and formation of colloidal gold, respectively. In unirradiated Au-glass, colloidal gold is formed after a heat treatment at above 800°C. In Mn-glass an absorption band is observed at 540 mμ after the irradiation. It is attributed to the change of the substitutional Mn^{2+} (substituted for Si^{4+}) into Mn^{3+}. On the other hand, the interstitial Mn^{2+} (substituted for Na^+) prevents the formation of F-centers, presumably because of the strong interaction between the free electron and Mn^{2+}, which is substituted for Na^+. The lack of electric neutrality at the vicinity of Mn^{2+} is suggested. It is shown from ESR experiments that the aggregation of Mn^{2+} does not occur in glass at room temperature. The experimental results about glasses containing other impurities are also briefly described. (auth)

13461 IRRADIATION-INDUCED COPOLYMERIZATION. Tabata. Kagaku Kojo, 7: No. 2, 54-8(1963). (In Japanese)

A review is presented on the general classification of copolymers, arranged in the order of decreasing regularity in structure, and nine series of copolymers induced by irradiation are described. These include: vinylidene chloride–isobutylene series; acrylonitrile–methyl methacrylate series; vinyl chloride–acrylonitrile series; styrene–acrylonitrile series; styrene–methyl methacrylate series; tetrafluoroethylene–ethylene series; tetrafluoroethylene–propylene series; tetrafluoroethylene–isobutylene series; and tetrafluoroethylene–vinyl chloride series. (P.C.H.)

13462 RADIOBIOLOGY. [PART] III. Honjo Ichijiro and Yuong-tchel Tchow (Osaka Univ.). Kagaku No Ryoiki, 17: 483-92(1963). (In Japanese)

Radiation chemistry is reviewed. The time sequence of events when radiation interacts with matter is described followed by a discussion of the characteristics of reactions in radiation chemistry. Radiolytic yield and the concept of G value are defined. The stepwise reactions that take place starting from initial activation to ionization are detailed, and distinctions are made between reactions in gas, liquid, or solid phases. Mechanisms of energy transfer within and between molecules are discussed leading to the theory of free radical formation. The radiation chemistry of water is also considered. This discussion includes formation of initial products, formation of molecular products, free radical reactions (H and OH radical reactions), and reactions in the presence of oxygen. (TTT)

13463 ELECTRON SPIN RESONANCE OF IRRADIATED SINGLE CRYSTALS OF ORGANIC COMPOUNDS. Yukio Kurita. Kagaku to Kogyo (Tokyo), 16: 885-91(1963). (In Japanese).

Single crystals of diglycolic acid monohydrate (2 × 2 × 5mm) were obtained by evaporating the aqueous solution and then gamma-irradiated with a 10^6R dose. The crystal was attached to a teflon rod with silicone grease and subjected to electron spin resonance study. Spectra were taken at two different crystal orientations as well as that of the powder. About one of 10^4 molecules was transformed to free radical by 10^6R dose. The radicals distributed themselves with the same symmetry of the parent molecules. This symmetry was destroyed by localized heating resulting from passage of hydrogen molecules. The free radical was identified as $HO_2CCH_2OC_2H_6CO_2H$. The CCOCC skeleton of this crystal is a planar trans, zigzag affair. Unpaired electrons are distributed about the C_α, H_α, and methylene H in a 0.70, −0.05 and 0.01 distribution. A discussion of internal molecular rotation and hydrogen exchange is included. (TTT)

13464 RADIATION-INDUCED REDOX CONVERSIONS OF ACCEPTORS IN ORGANIC SOLVENTS. V. CONVERSIONS OF KI AND I_2 IN ACETONE SOLUTIONS. M. Roder, Kun Go, N. A. Bakh and L. T. Bugaenko (Inst. of Chemical Physics, Academy of Sciences, USSR). Kinetika i Kataliz, 5: 976-80(Nov.-Dec. 1964). (In Russian)

Studies of x-ray effects on dilute acetone solutions of KI and I_2 (in the presence of KI) showed that radiation does not induce I^- oxidation in the absence of oxygen. The disappearance of iodine with a maximum yield of $G(-I_2) = 2.1 \pm 0.1$ equiv/100 ev in a 2×10^{-4} M I_2 solution was observed during the irradiation of I_2 + KI solutions in vacuum. Irradiation of KI solutions in the presence of oxygen resulted in I^- oxidation to I_2. The maximum oxidation yield in 2×10^{-3} M solution was 5.2 ± 0.2 equiv/100 ev. A change

in I_2 concentration was observed following the irradiation. (tr-auth)

13465 STEPWISE RECOMBINATION OF FREE RADICALS IN IRRADIATED ORGANIC COMPOUNDS. I. EXPERIMENTAL INVESTIGATION OF RECOMBINATION KINETICS. A. I. Mikhailov, Ya. S. Lebedev, and N. Ya. Buben. Kinetika i Kataliz, 5: 1020-7(Nov.-Dec. 1964). (In Russian)

Stepwise recombination kinetics of solid-state free radicals were studied using a series of organic substances (glycine, malonic, acetic, and palmitic acids, phenol, and naphthalene). The kinetic recombination interruption was observed in organic and inorganic compounds of various chemical structures. Moreover, the concentration of stable radicals at the given temperature usually diminished linearly with the rise of temperature. It was also shown that the rate of a quasi-stationary concentration of phenols increased with the increased rate of specimen heating to a certain temperature. (R.V.J.)

13466 THE ACTION OF DIFFERENT KINDS OF IONIZING RADIATION ON CATALYTIC DEHYDRATION OF N-DECYL ALCOHOL AND ON ISOMERIZATION OF ALPHA-DECENE. G. N. Pirogova and Vikt. I. Spitzyn (Inst. of Physical Chemistry, Academy of Sciences, USSR). Kinetika i Kataliz, 5: 1034-9(Nov.-Dec. 1964). (In Russian)

Effects of different types of radiations on the dehydration reaction in n-decyl alcohol and on the isomerization of α-decene over aluminum oxide were investigated. It was found that preliminary x-irradiation of Al_2O_3 and irradiation during the reaction increased the rate of alcohol conversion. The exposure of Al_2O_3 to slow neutron and γ treatment in a reactor and to ^{60}Co γ rays inhibited the rate of the dehydration reaction. A preliminary irradiation of Al_2O_3 by fast electrons did not affect the rate of the alcohol conversion reaction. (R.V.J.)

13467 ESR STUDIES ON THE RECOMBINATION OF FREE RADICALS IN IRRADIATED ORGANIC MONO-CRYSTALS. Yu. D. Tzvetkov and O. V. Faleev. Kinetika i Kataliz, 5: 1119-23(Nov.-Dec.). (In Russian)

Recombination kinetics of solid-state free radicals at room temperature were studied in x-irradiated monocrystals of amino and dicarboxylic acids (succinic, adipic, camphoric, and α-aminoisobutyric acids and alanine). The annealing curves of the free radical concentration as a function of temperature showed that the most intense recombination occurred at the range from 0.75 to 0.95 T/T_{melt}. The recombination temperature range for the above substances was 30 to 40°C. It was revealed that to 3 Mrad the recombination kinetics did not depend on irradiation. (R.V.J.)

13468 X-RAY LUMINESCENCE OF QUARTZ. J. Lietz and J. Matheja (Universitat, Hamburg). Naturwissenschaften, 51: 503-5(1964). (In German)

If quartz is exposed to x radiation, it emits luminescence consisting of two bands with maxima at 2.5 and 3.3 ev. Crystals not thermally treated emit only or extensively at 2.5 ev, and the luminescence intensity increases with the logarithm of the irradiation time. The 3.3-ev band was destroyed by x radiation in the tempered crystal, but the 2.5-ev band remained constant. The spectral distribution showed a characteristic temperature dependence. X radiation also produced a modification of the radiation capacity, which was remarkably stable. (J.S.R.)

13469 RADIOLYSIS OF CYCLOHEXYLAMINE AND N,N-DIMETHYLCYCLOHEXYLAMINE. Haruhiko Hisada, Setsuo Takamuku, and Hiroshi Sakurai (Osaka Univ.). Nippon Kagaku Zasshi, 86: 31-4(Jan. 1965). (In Japanese)

The radiolysis of cyclohexylamine (CHA) and N,N-dimethylcyclohexylamine (DM-CHA) in the liquid phase was investigated. The G value of hydrogen, which was a main non-condensable product, was independent of the total dose ($(0.1$ to $2.6) \times 10^{20}$ ev/g) and the irradiation temperature (−196 to 50°C). The G values were 5.9 and 4.5 respectively, for CHA and DM-CHA. Methane was also produced from the radiolysis of DM-CHA and its G value was 0.6. The presence of a radical scavenger such as methyl methacrylate or tetrachloroethylene in the radiolysis of these amines reduced the $G(H_2)$. It was found by kinetic analyses that 78 and 73% of the hydrogen produced in the radiolysis of CHA and CM-CHA arose from thermal hydrogen atoms. From the radiolysis of benzene-amine mixtures, the protective effect of benzene was also observed and was discussed in terms of an energy transfer mechanism. (auth)

13470 POLARIZATION ABILITY OF CATIONS AND FORMATION OF HYDROGEN PEROXIDE IN AERATED AQUEOUS SOLUTIONS OF SULPHATES EXPOSED TO Co-60 GAMMA-RADIATION. II. TEMPERATURE AND CONCENTRATION DEPENDENCE OF PROCESS FOR Li^+, Na^+, K^+, Rb^+, AND Cs^+ SOLUTIONS. Stefan Minc and Eugeniusz Wezranowski (Inst. of Nuclear Research, Warsaw). Nukleonika, 9: 857-62(1964).

The effects of the hydration energy of cations in 0.20, 0.90, and 1.50 M aqueous solutions of Li, Na, K, Rb, and Cs sulfates on the yield of hydrogen peroxide $G(H_2O_2)$ was investigated. The dependence observed between the temperature of the solution and the $G(H_2O)$ indicated the diffusional character of the process of passing of radicals from the spur into the solution. The diffusion rate of the radicals from the spur increased with the rise of temperature and so did $G(H_2O_2)$ reaching a state of equilibrium at 60—80°C. The $G(H_2O_2)$ diminished, on account of the increasing difficulty in the process of diffusion of the radicals from the spur into the solution, with rising concentration of the cation. (auth)

13471 CHEMICAL EFFECTS IN NEUTRON CAPTURE. II. INFLUENCE OF ULTRASOUND ON NEUTRON-IRRADIATED AMMONIUM SULFATE AND POTASSIUM SULFATE. Nikola Getoff. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 10, 211-19(1963). (In German)

A study was made to determine if the chemical transformations in a neutron-irradiated solid could be reversed by ultrasonics. Samples of crystalline potassium sulfate and ammonium sulfate were exposed to a total neutron dose of about 1.6×10^{15} or 3.6×10^{16} n/cm^2. The sulfite and sulfate were separated, and the concentration of each was determined by measurement of the ^{35}S activity. In the potassium sulfate, the retention (ratio of the ^{35}S activity in the sulfate to the total ^{35}S activity) first increased rapidly with ultrasonic treatment. After 8 to 12 hrs a saturation point was reached, and the retention decreased. It was concluded that two processes occur as the result of the ultrasonic treatment of neutron-irradiated potassium sulfate: photochemical annealing and photolysis. In the ammonium sulfate ultrasonics led to less annealing than in the potassium sulfate. A strong photolysis occurred, which can be traced back to the ammonium group. It was established that hydrazine was formed in the neutron irradiation, and ultrasonics caused an additional formation of hydrazine. (J.S.R.)

13472 EPR SPECTRA OF PEROXY RADICALS IN IRRADIATED ORIENTED POLYTETRAFLUOROETHYLENE. D. W. Ovenall (E. I. du Pont de Nemours and Co., Wilmington, Del.). Phys. Chem. Solids, 26: 81-4(Jan. 1965).

EPR measurements at 77 and 296°K on oriented polytetrafluoroethylene (PTFE) samples irradiated in vacuum and then exposed to air are reported. At 77°K, the spectral line shapes can be understood assuming that the radicals are essentially stationary and have an axially symmetric g-tensor with $g_{\parallel} = 2.04$ and $g_{\perp} = 2.002$. These values were compared with those of other radicals in which the unpaired electron is thought to be located mainly on an oxygen atom. At 296°K, the spectra are narrower, showing the occurrence of motion. This is probably an oscillation about the polymer chain axis. (P.C.H.)

13473 ABSOLUTE MEASUREMENT OF W FOR POLONIUM-210 ALPHA PARTICLES IN NITROGEN, ARGON, AND AN ARGON-METHANE MIXTURE. Z. Bay and F. D. McLernon (National Bureau of Standards, Washington, D. C.). Radiation Res., 24: 1-8(Jan. 1965).

Absolute Wα values (average energy expended in the creation of an ion pair) were measured for ^{210}Po α-particles by slow and fast methods in: pure argon; 90% argon plus 10% methane; and pure nitrogen. There was agreement for all Wα values measured by the fast method with earlier results measured by the slow method. This, besides giving an improved accuracy in some gases, corroborated findings where the equivalence of the two methods was established. (H.M.G.)

13474 ELECTRON BEAM IRRADIATIONS OF 1,2,3,4-TETRAHYDRONAPHTHALENE. R. Y. Mixer, R. H. Williams, J. G. Bendoraitis, S. W. Chaikin, and E. A. Oberright (Stanford Research Inst., Menlo Park, Calif. and Socony Mobil Oil Co., Princeton and Paulsboro, N. J.). Radiation Res., 24: 57-66(Jan. 1965).

Tetralin was irradiated with 1-Mev (nominal) electrons in helium, helium-oxygen, and oxygen atmospheres. Major interest was in the yield and structure of the liquid radiation products. The effects of temperature and dose in helium were studied. In a helium atmosphere the main liquid product was 1,1'-bitetralyl. Polymers up to a tetralin hexamer were found. In oxygen-containing atmospheres, polymeric tetralols were the major products; lesser amounts of carbonyl compounds and hydroperoxides were formed also. Appreciable amounts of unoxidized polymer were obtained in the presence of oxygen, and the hydrogen yield was greater than in comparable experiments in the helium atmosphere. (auth)

13475 PROTEIN LABELLING WITH RADIOIODINE BY ELECTROCHEMICAL WAY. NOTE II. PREPARATION OF MONO- AND DI-IODOTYROSINE LABELLED WITH ^{131}I AT VERY HIGH SPECIFIC ACTIVITY. C. Ambrosino, J. Liberatori, A. Massaglia, and U. Rosa (Universitá, Turin and SORIN, Saluggia, Italy). Ric. Sci., Rend., Sez. B (2), 4: 681-6(June 1964).

The electrolytic labeling method enables mono- and di-iodotyrosine at high specific activity to be prepared. By a suitable choice of the electrolysis conditions it is possible to obtain mainly mono- or di-iodotyrosine, with high labeling yields. The following purification of iodotyrosines through thin layer chromatography shows, in comparison with the conventional methods of paper chromatography, the remarkable advantage that a solution volume about double can be laid down on every plate. The following extraction of MIT and DIT from the inorganic support is moreover considerably faster and may be performed with higher yields. The risk of an ambient contamination due to iodine losses in gaseous form appears to be remarkably reduced in comparison with the chemical methods so far known. (auth)

13476 GAMMA RADIATION EFFECTS ON THERMAL DECOMPOSITION OF $(NH_4)_3[Fe(C_2O_4)_3]\cdot 2.2\ H_2O$. Khoriguti Giiti. Rika Gaku Kenkyusho Hokoku, 39: No. 1, 40-3 (1963). (In Japanese)

Gamma irradiation (^{60}Co) changed the color of $(NH_4)_3[Fe(C_2O_4)_3]\cdot 2.2\ H_2O$ (I) from green to orange, decreased the C content, and produced CO_2, Fe^{2+}, and $(C_2O_4)^{2-}$. When I was heated, the water of crystallization decreased from 2.2 to 1.7 between 54 and 182°C; $FeCO_3$ formed between 182 and 257°C; α-Fe_2O_3 was completely formed at 257-380°C. Heat converted γ irradiated I to a mixture of $(NH_4)_2[Fe(C_2O_4)_2]\cdot 2.2\ H_2O$ (I') and $(NH_4)_2C_2O_4$. At 43°C I' lost its water of crystallization. At 156-190°C, the $(NH_4)_2C_2O_4$ decomposed. At 190-249°C anhydrous I' changed to $FeCO_3$ and above 249°C became Fe_2O_3 of undetermined form. (TCO)

13477 ON THE RADIOINDUCED CHANGES IN UNSATURATED C_{18}-FATTY ACIDS IN AQUEOUS, AIR-CONTAINING SOLUTIONS. Dietrich Eberhagen, Istvan Klempay, and Nepomuk Zoellner (Universitat, Munich). Strahlentherapie, 126: 132-44(Jan. 1965). (In German)

Aqueous solutions of stearic, oleic, linoleic, and linolenic acids were x irradiated with doses between 100 and 100,000 R. The fatty acids were extracted from the solution at different intervals after irradiation and the content of oxidizing substances was determined. Also, thin layer chromatographic investigations were done. The radioinduced formation of reducible compounds from the fatty acids depended upon the radiation dose, on the degree of unsaturation of the substances, and on the incubation duration after irradiation. Using thin layer chromatography, several reducible compounds were found in linoleic acid. The unsaturated fatty acids showed a biphasic curve with a maximum in oxidizing compounds immediately after irradiation; another maximum appeared one hour later. At periods longer than one hour, however, the content in oxidizing compounds increased only slightly. No oxidizing compounds could be found in the solution 30 min after irradiation. A polar mechanism, not based on free radicals, is used for the explanation of the oxidation course. (auth)

13478 CHEMICAL APPLICATIONS OF THE MÖSSBAUER EFFECT. PART 1. THE BONDING IN IRON BORIDES. J. D. Cooper, T. C. Gibb, N. N. Greenwood, and R. V. Parish (Univ. of Newcastle-upon-Tyne, Eng.). Trans. Faraday Soc., 60: 2097-2104(Dec. 1964).

The evidence for electron transfer between metal and boron atoms in metal borides of the type M_2B and MB is discussed critically. It was concluded that transfer occurs from boron to metal. Confirmation of this was obtained from the Mössbauer spectra of Fe_2B and FeB, which were consistent with the three band model proposed by Lundquist. (auth)

13479 ELECTRON SPIN RELAXATION IN FREE RADICALS DERIVED FROM POLYMETHYLMETHACRYLATE. A. T. Bullock and L. H. Sutcliffe (Liverpool Univ.). Trans. Faraday Soc., 60: 2112-24(Dec. 1964).

The electron spin resonance spectra of free radicals generated in different ways in polymethylmethacrylate saturated readily at moderate values of microwave power. From an analysis of this behavior (found to be intermediate in character between that of homogeneously and inhomogeneously broadened lines) values of the spin-lattice and spin-spin relaxation times were estimated for several samples at 299 and 77°K. It was concluded tentatively that spin-lattice relaxation occurs via spin-orbit coupling. The variation of the spin-spin relaxation times with temperature in the γ-irradiated samples provided strong and direct evidence for the formation of radicals in spurs while the severe spectral asymmetry observed at high microwave power levels gave support to the view that two radicals are responsible for the characteristic features of the electron spin resonance spectra. (auth)

13480 LUMINESCENCE OF GASES EXCITED BY HIGH-ENERGY RADIATION. PART 1. COLLISIONAL DEACTIVATION IN NITROGEN. B. Brocklehurst (Univ. of Sheffield, Eng.). Trans. Faraday Soc., 60: 2151-7(Dec. 1964).

When nitrogen and nitrogen + oxygen mixtures, in the pressure range from 1 to 750 mm Hg were excited by soft x rays, the strongest emission features in the visible and ultraviolet spectrum were the second positive bands ($C^3\Pi_u - B^3\Pi_g$ of N_2) and first negative bands ($B^2\Sigma_u^+ - X^2\Sigma_g^+$ of N_2^+). Intensity measurements showed that the N_2^+ B state is deactivated in approximately every collision with ground-state nitrogen and oxygen molecules, if normal gas-kinetic cross sections are assumed. This was also true of the N_2C state in collision with oxygen, while the cross sections for deactivation by nitrogen were about one-thirtieth and one-tenth of the gas-kinetic cross section for $\nu' = 0$ and 1 respectively. (auth)

13481 TRANSFORMATION OF BERYLLIUM IN Be_2C AND BeO BY ELECTRON IRRADIATION IN REGARD TO HYDROCARBON POLYMERIZATION. G. Moellenstedt, H. Pollak, and H. Seiler (Universitat, Tubingen, Ger.). Z. Physik, 182: 445-50(1965). (In German)

The secondary electron yield from beryllium surfaces in presence of residual hydrocarbon vapor at a vacuum of 10^{-4} torr decreases with time from $\delta = 0.45$ to 0.25 when the incident primary electrons hit the target with an energy of 28 kev and an incident angle of 60°. Since the yield from the

hydrocarbon polymer contamination layer is 0.3, it is concluded that the beryllium surface reacts with the contamination layer. This is confirmed by electron diffraction and electron microscopic observation of thin beryllium layers on different supporting foils, i.e. C-, Al_2O_3, polymeride from gas discharges, and self supporting Be. When a beryllium foil about 500 Å in thickness is first irradiated with low intensity (total beam current in the Siemens Elmiskop I $I < 5\ \mu A$), a polymeride layer is formed. After increasing the beam current to 30 μA, the micrographs as well as the Debye-Scherrer diagrams show the formation of Be_2C and BeO. It is supposed that the carbon originates from the polymeride layer, and that the oxygen is supplied by the residual gas. (auth)

13482 RADIATION CHEMISTRY OF OXYCHLORINE COMPOUNDS. II. CONVERSIONS IN AQUEOUS SODIUM CHLORITE SOLUTIONS OF MEDIUM AND HIGH CONCENTRATIONS. L. T. Bugaenko (Moscow State Univ.). Zh. Fiz. Khim., 38: 2899-2906(Dec. 1964). (In Russian)

The conversion of the chlorite ion in 0.001 to 4.5 $NaClO_2$ solutions saturated with nitrogen, hydrogen, air, and oxygen caused by 65-kv peak x rays was investigated. It is shown that decomposition of chlorite is due to its reaction with both radical and non-radical products of radiolysis of water as well as with its own reduction products. A mechanism for the reaction is proposed. The ratios of the reaction constants $K_{ClO_2^- + OH}/K_{ClO_2^- + OH}$ and $K_H + O_2 K_H + ClO_2^-$ were calculated to be 0.030 + 0.010 and 86 ± 8, respectively. It is shown that chlorine dioxide is an efficient acceptor of radicals formed in the radiolysis of water. The chlorate ion is a weak acceptor of H and OH radicals. (auth)

13483 GAMMA IRRADIATION OF DISULFIDES, THIOLSULFINATES AND THIOLSULFONATES. Paul J. Berner. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1964. 262p.

A survey was made of the effect of gamma radiation from cobalt-60 on mercaptans, disulfides, thiolsulfinates, and thiolsulfonates belonging to the dodecyl, phenyl, p-tolyl, and benzyl series. These compounds were irradiated in the pure state (most were crystalline solids). Irradiations were carried out in nitrogen, and in the presence and absence of air. The usual dose was 10^8-10^9 roentgens; the dose rate varied from 125–450 kiloroentgens/hour. Analytical methods for identification and estimation of irradiation products were developed (particularly for dodecyl compounds). All mercaptans studied gave disulfides on irradiation. Hydrogen was identified in irradiated dodecyl mercaptan (DSH). Hydrogen sulfide formation is insignificant. All disulfides studied were essentially unchanged on irradiation with these dosages. Mercaptan was absent from all irradiated disulfides. Dodecyl and aryl thiolsulfinates undergo decomposition on irradiation, to give initially disulfide and thiolsulfonate in approximately equal amounts. Sulfonic acid is formed upon continued irradiation. More acid is produced in air than in nitrogen. Less acid is formed from aryl thiolsulfinates than from dodecyl thiolsulfinate. Formation of dodecyl thiolsulfonate (DSO_2SD) from dodecyl thiolsulfinate in air is virtually constant over the range $1 \times 10^8 - 3 \times 10^8$ roentgens. DSO_2SD irradiated in air decomposes linearly with dose. Acid content in DSO_2SD irradiated in nitrogen decreases at higher dose. Aryl thiolsulfonates are more stable than dodecyl thiolsulfonate. Tolyl thiolsulfonate is practically unaltered at 10^8 roentgens; phenyl and benzyl thiolsulfonates are increasingly labile. Phenyl and benzyl thiolsulfonates give disulfide and small amounts of acid. Tables of G values, and a relative stability list are given. (A.G.W.)

13484 CHEMICAL REACTIONS OF N^{13} RECOILS FROM THE $C^{12}(d,n)N^{13}$ REACTION. W. S. Koski, D. Malinin, and M. Berta (Johns Hopkins Univ., Baltimore). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/73, 11p. (CONF-773-28)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

An investigation was made on ^{13}N recoils from $^{12}C(d,n)^{13}N$ reactions in benzene and CF_4. In addition, reactions of N^+ ions with CCl_4 and CF_4 were examined in a tandem mass spectrometer. In the case of ^{13}N recoils reacting with benzene, HCN was the main product and small amounts of benzonitrile were formed. No aniline or pyridine were produced. This will be contrasted with reported studies in which active nitrogen produced by electrical discharge reacted with benzene. In the case of CF_4, the only radioactive product detected was FCN. In both cases, polymeric materials were produced on the walls of the reaction vessels. No other products such as NF_3 were detected. Studies of the effect of rare gas additives in the case of methanol indicated that ion-molecule reactions were involved at least in part. For this reason, the reactions of N^+ ions with CCl_4 and CF_4 were studied in a tandem mass spectrometer in the bombarding ion energy range from 2 to 200 ev. The relative cross-sections for various ion production were investigated as a function of energy. In addition to ions composed of carbon and chlorine, various nitrogen-containing ions such as NCl^+, $CNCl^+$, and CN^+ were detected. The shapes of the cross-section curves were such as to indicate complex formation possibly $(CCl_4N)^+$ which decomposed to give the product ions. The above complex was not detected directly. In addition to the above attempts to detect intermediates that may shed information on the hot atom processes in question here, some preliminary electron spin resonance studies were made on nitrogen recoil systems. $^{14}CH_3OH$ at liquid nitrogen temperatures was examined by ESR in an attempt to detect significant radicals that may be intermediates in the hot atom process. Some indication was obtained of the presence of cyanide radicals resulting from the ^{14}N recoils from the β decay of ^{14}C. However, the results are not unambiguous because of the large amounts of radiation damage free radicals such as $.CH_2OH$ that are present. The results are discussed in the light of a possible mechanism for the ^{13}N recoil processes. (P.C.H.)

13485 THE REACTIONS OF HOT FLUORINE-18 WITH GASEOUS CARBON TETRAFLUORIDE. N. Colebourne, J. F. J. Todd, and R. Wolfgang (Yale Univ., New Haven). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-55/72, 29p. (CONF-773-29)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

New data on the reactions of hot ^{18}F atoms with CH_4 and CF_4 are reported. Gaseous samples were exposed to a 40–60 Mev (maximum) bremsstrahlung beam. The $^{19}F(\gamma, n)^{18}F$ process produces ^{18}F with a kinetic energy of the order of 10^5-10^6 ev. These species lose energy by collision and are expected to reach the chemical energy range (<100 ev) as ground state atoms. Ethylene was found to be a good scavenger for thermal ^{18}F atoms. Analysis of products was made using standard radio-gas chromatography techniques. The system was found to be quite sensitive to extraneous radiation damage effects and appropriate precautions were taken. Hot displacement reactions similar to those observed for hot hydrogen, but much less efficient, were found. Detailed studies of the effect of moderator on the $^{18}F + CF_4$ system were made. The data obtained were analyzed by means of the kinetic theory of hot reactions. The system was found to be in accord with this formalism, providing quantitative confirmation of the interpretation of the results. The CF_4 and CH_4 systems provide a basis for some tentative conclusions on the mechanisms of hot fluorine atom reactions. At present it appears that with certain important, but natural, modifications the model first developed for hot hydrogen atoms is applicable. (P.C.H.)

13486 MOLECULE SYNTHESIS BY β-DECAY AND NUCLEAR FISSION. F. Baumgaertner (Technische Hochschule, Munich). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/20, 18p. (CONF-773-14)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The existence and properties of some possible chemical compounds that could be synthesized by β-decay were investigated. One of these compounds was dibenzene-technetium(I), $Tc(C_6H_6)_2^+$, which was produced for the first time by β-transformation of dibenzene-molybdenum: $^{99}Mo(C_6H_6)_2 \xrightarrow{\beta^-} {}^{99m}Tc(C_6H_6)_2^+$. From carrier-free amounts of the compound the properties were determined and the subsequent chemical synthesis facilitated. In a similar manner cyclopentadienyl technetium tricarbonyl, $C_5H_5Tc \cdot (CO)_3$, was produced for the first time, by β-decay of the ^{99}Mo in $(C_5H_5{}^{99}Mo(CO)_3)_2$: $(C_5H_5{}^{99}Mo(CO)_3)_2 \xrightarrow{\beta^-} C_5H_5{}^{99m}Tc \cdot (CO)_3$. From the volatile β-decay product of radioactive ruthenocene, $^{105}Ru(C_5H_5)_2$, conclusions were drawn concerning the existence of the hypothetical $Rh(C_5H_5)_2$, formed by β-transformation: $^{105}Ru(C_5H_5)_2 \rightarrow {}^{105}Rh(C_5H_5)_2$. However, subsequent chemical synthesis produced cyclopentadienyl-rhodium(I)-cyclopentadiene, $C_5H_5RhC_5H_6$. Experiments were also performed with a freely-chosen target compound mixed with a uranium compound as a source of long-range fission atoms. In this way ferrocene, $Fe(C_5H_5)_2$, was transformed by uranium fission to ruthenocene and iodo-ferrocene, and chromium hexacarbonyl, $Cr(CO)_6$, to molybdenum hexacarbonyl, $Mo(CO)_6$. The rule for substitution of fission products in monohalobenzenes and in the two isomeric iodonaphthalenes was also studied. Furthermore, the different stages during the lifetime of a fission product were investigated for their connection with molecule formation. It was found that after the fission-product atoms are transported into the admixed target compound by fission recoil the newly formed molecules are built without the use of molecular fragments from the slowing down process and without any help from the slowing down process or from radiation-induced defects. The origin of molecule formation lies in the β-transformations of the fission products alone. (P.C.H.)

13487 PHOTO-ANNEALING AND THERMAL ANNEALING OF ^{32}P RECOILS IN NEUTRON IRRADIATED POTASSIUM CHLORIDE. J. Cifka (Nuclear Research Inst. of the Czechoslovak Academy of Sciences, Rez, Czechoslovakia). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/65, 17p. (CONF-773-12)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Considerable photoannealing of ^{32}P recoils was found during the study of neutron irradiated potassium chloride. The effects of light and thermal treatment are described. As a target material, potassium chloride recrystallized from water was used. The crystals were irradiated (neutron flux approximately 5.10^{11} $n.cm^{-2}sec^{-1}$) and stored at dry ice temperature. All operations with irradiated crystals were carried out in the dark. The initial reduction of ^{32}P recoils followed by an oxidation process was found during the thermal treatment in darkness. In the temperature range from 20 to 120°C the dark thermal-annealing curves were quite different as compared with the curves obtained for neutron irradiated crystals exposed to daylight during handling; the reduction was more rapid for the last ones. At temperatures above 150°C the thermal-annealing curves were nearly the same for both cases. The photoannealing of ^{32}P was studied for the daylight and the 5500 Å light, respectively. The curves obtained were compared with color center bleaching curves measured on the same target material. The reduction of ^{32}P recoils occurred during photoannealing, the rate of reduction being higher for P^{3+} recoils than for P^{5+} recoils. The kinetics of reduction of ^{32}P recoils during both thermal and photoannealing is discussed. (P.C.H.)

13488 THE CHEMICAL EFFECTS OF THE Br^{80m} I.T. Br^{80} AND $Br^{81}(n,\gamma)Br^{82}$ NUCLEAR TRANSFORMATIONS IN SOLID ORGANIC SYSTEMS. R. M. A. Hahne and J. E. Willard (Univ. of Wisconsin, Madison and Kernforschungsanlage, Jülich, Germany). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/21, 16p. (CONF-773-19)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The chemical effects of the ^{80m}Br I.T. ^{80}Br and $^{81}Br(n,\gamma)^{82}Br$ nuclear transformations were studied in solid organic systems. At 77°K significant differences were observed between the organic yields for bromine-scavenged, glassy and polycrystalline alkyl bromides. For those bromine-scavenged systems in which most or all of the activated bromine atoms originated in organic combination, the organic yield was found to be higher for the crystal than for the glass; the reverse was the case when the activated bromine atoms originated in molecular bromine. Bromine scavenger concentration was found to have a greater effect on organic yields for glasses, in comparison to those for polycrystals. The organic product distribution of ^{80}Br following the isomeric transition of $Br^{80m}Br$ was studied extensively for both glassy and polycrystalline systems, using radiogas chromatography. E.S.R. and gas chromatographic studies of γ irradiated alkyl bromide-bromine systems showed that the glassy and polycrystalline solids behave quite differently with respect to radical trapping, thermal annealing, and stable product formation. (auth)

13489 EFFECT OF THE (n,α) NUCLEAR REACTION OF B^{10} AND Li^6 ON THE RETENTION OF NUCLEAR RECOIL ATOMS IN SOLIDS. P. N. Dimotakis and M. I. Stamouli (Nuclear Research Centre Democritus, Athens). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/47, 15p. (CONF-773-22)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The increase of initial retention in reactor irradiated solid cobaltic complexes, chromates, and dichromates can be achieved by mixing the compounds with highly powdered boron compounds (α-annealing). The thermal neutron fission products of ^{10}B and particularly the α particles can penetrate the crystal lattice of the material under examination and by introducing defects into it to help the recombination of the recoil interstitials with their parent vacancies. Potassium chromate seemed to increase the ^{51}Cr retention up to 12% when it was bombarded by neutrons in mixtures with powdered boric acid. Ammonium chromate and potassium dichromate did not show any increase. Trisethylenediamine cobalt (III) nitrate in mixtures with ammonium hydrogen tetraborate showed an increase of retention about 15% for a dose given from the (n,α) reaction of 20 MRad. Lithium carbonate was also used in mixtures with potassium chromate and dichromate and ammonium chromate. An increase of about 9% of retention was achieved in potassium chromate. Ammonium chromate in mixtures with lithium carbonate showed an increase of 3.5% due to the (n,α) reaction while potassium dichromate showed an increase of 2%. The introduction of defects by the products of the (n,α) reaction of ^{10}B and ^6Li affects the isothermal annealing, increasing the irregularities as the dose due to the fission products increases. The dose was calculated from the Q of the nuclear reaction and it was assumed that all of it was absorbed by the lattice. By microscopic examinations the size of microcrystals of boron and lithium compounds was found to be of the order of a few microns, which allowed the fission products to cross the parent lattice and come into the examined material. (auth)

13490 CHEMICAL BEHAVIOR OF C^{11} IN LIQUID HYDROCARBONS. A. F. Voigt, D. E. Clark, and F. G. Mesich (Iowa State Univ. of Science and Tech., Ames). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/68, 20p. (CONF-773-24)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The chemical behavior of ^{11}C was studied by gas chromatographic separation of liquid hydrocarbon products, counting the ^{11}C in the gas stream in a cell placed in a well-type scintillation counter. In each experiment yields of

different products were compared to that of acetylene as an internal standard and to the total ^{11}C produced as measured in the entire sample before separation. The flow counters were calibrated in terms of total ^{11}C produced in experiments in which the complete sample was burned to CO_2 and passed through a flow counter. The results proved very helpful in deciding on mechanisms for recombination of recoil atoms. Of particular interest is the yield of product with one carbon more than the target (n + 1 product), the result of an addition reaction. The location of the additional atom on a target molecule having several types of addition sites gave information regarding the process itself. When the recoil atom is slowed to an energy at which it is possible for a bond to be formed, at least temporarily the extra energy which the ^{11}C atom brings into the system may cause bond rupture elsewhere within the activated complex usually leading to a two-carbon product. If the complex is able to hold together without rupturing, an n + 1 product will result. Thus comparison of the yields of two-carbon compounds, acetylene, ethylene, and ethane, and the n + 1 products provided valuable information regarding the critical energy at which stable bond formation can occur. (P.C.H.)

13491 A TRIGGERING MECHANISM FOR THE PROMOTION OF THERMAL ANNEALING IN CRYSTALLINE HEXABROMOETHANE BY RADIATION PRODUCED DEFECTS. K. E. Collins (State Univ. of New York, Buffalo). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/4, 19p. (CONF-773-25)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

A model for radiation promoted annealing is suggested that incorporates the idea that species from the bulk of the crystals can, in some cases, act as rate determining factors in the hot atom annealing of hexabromoethane. Experimental facts about the several different types of annealing in hexabromoethane are described in terms of the proposed model. The model assumes two types of radio-induced species that are stable in the crystalline hexabromoethane at −196°C. One of these species can diffuse at annealing temperatures to interact with recoil-^{82}Br sites and promote the thermal annealing of these sites. The other can trap or annihilate the diffusing species. (P.C.H.)

13492 THE EFFECT OF THE AMMONIUM GROUP ON THE DIFFERENT ANNEALING PROCESSES. N. Getoff (Österreichische Studiengesellschaft fur Atomenergie GmbH, Vienna). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/91, 18p. (CONF-773-26)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The effects of the ammonium group on different annealing processes in neutron irradiated ammonium compounds were investigated. Data are reported, showing the influence of the ammonium group on the thermal, radiation, and ultrasonic annealing of mono-, di- and triammoniumphosphates. It was established that under the conditions of neutron irradiation in the pile the ammonium group in a compound can be transformed into certain metastable recoil fragments, which can lead to the formation of reducing substances, e.g., hydrazine. The yield of hydrazine is increasing through a subsequent treatment of the neutron irradiated solid samples with gamma rays, ultra sound, etc. Simultaneously with the raise of the hydrazine yield a strong change of the retention occurs. (P.C.H.)

13493 THERMAL AND GAMMA-RADIATION ANNEALING OF THE IRIDIUM-192 RECOIL SPECIES IN CRYSTALLINE $Na_2IrCl_6 \cdot 6H_2O$. R. Bell and W. Herr (Kernforschungsanlage, Jülich, Germany and Universität, Cologne). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/18, 16p. (CONF-773-32)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Carrier-free ^{192}Ir-labeled compounds were studied as regards their behavior towards reducing and oxidizing agents and aging in solution. Independently the hydrolysis of the hexachloro complexes of ter- and quadrivalent iridium, which were labeled with ^{36}Cl and ^{192}Ir, was investigated. A comparison between these two series of results supported by further results from neutron activation analysis enables the recoil products to be identified mostly as octahedral complexes of Ir-III containing Cl^-, H_2O, and OH^- ligands to different extent. Evidently the water of crystallization plays an important role in the formation of the recoil species. Thermal annealing of these products at 120°C showed a rapid decrease in the yields of the aquochloro, hydroxochloro, and aquohydroxochloro complexes towards formation of the mother compound excepting the pentachloro complex. Gamma radiation annealing revealed many single steps, whose general trend was a transition from lesser Cl-containing species to a higher Cl content leading finally to the hexachloro complex. This showed that the annealing process consists in the re-entering of Cl atoms (or ions) into the ligand sphere with the accompanying displacement of H_2O as well as OH (OH^-). The results are in remarkable agreement with the concept of a stripping mechanism of Cl atoms and/or ions caused by the nuclear reaction of the central iridium atom. (P.C.H.)

13494 IONIZATION THAT FOLLOWS A HEAVY-ION INDUCED NUCLEAR REACTION. N. H. Steiger (Israel Inst. of Tech., Haifa). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/28, 29p. (CONF-773-30)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Initial results are given of an experimental study on the internal ionization effect that follows a heavy-ion-induced nuclear reaction. Charge spectrometry by means of magnetic analysis of the reaction products was applied. The effect was investigated for the reaction $^{141}Pr(^{16}O,8n)^{149}Ho$. The bombarding energy was 10.4 ± 0.2 Mev. ^{141}Pr target thicknesses from 26.2 down to 9.7 $\mu g/cm^2$ were used. For target thicknesses lower than about 25 $\mu g/cm^2$, non-equilibrium ionic-charge spectra were obtained that tend toward lower probabilities for the charge states lower than the equilibrium mean charge, and tend toward higher probabilities for the charge states higher than the equilibrium mean charge. As a result, the mean ionic charge increases from 17.6 ± 0.5 for the equilibrium case to 19.4 ± 1.0 for a target thickness of 9.7 $\mu g/cm^2$. By extrapolation to target thickness zero, an ionic-charge spectrum was obtained that was considered to illustrate the instantaneous internal ionization obtained for the interaction between two complex nuclei. Instantaneous internal ionization is defined as the ionization that takes place before the resulting species of a nuclear reaction starts moving inside the target material and is given the chance of charge-changing collisions. The shape of the resulting extrapolated charge spectrum can be explained as being mainly composed of the two processes responsible for the internal ionization: the non-diabatic part of the transition following the large change in nuclear charge (Z = +8); and the development of vacancy cascades as a result of internal conversion. Based on the experimental results, the part of the ionization due to process was estimated to be less than 800 ev. (P.C.H.)

13495 CHEMICAL EFFECTS OF THE (n,p) REACTION IN GASEOUS SYSTEMS. SIMPLE ALKANES AND THEIR CHLORODERIVATIVES. K. Panek and K. Mudra (Nuclear Research Inst. of the Czechoslovak Academy of Sciences, Rez, Czechoslovakia). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/64, 17p. (CONF-773-13)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The chemical effects accompanying the reaction $^{35}Cl(n,p)^{35}S$ in organic systems were studied. Chemical species in which the hot ^{35}S atoms are stabilized were considered

first. Methyl chloride, ethyl chloride and methane-hydrogen chloride mixture in gaseous state were used as target materials. All samples were prepared by vacuum technique and irradiated in a horizontal channel of the VVR-S reactor. The irradiated samples were analyzed by radio-gaschromatography. The pressure dependence of yields of individual species was also investigated in methyl chloride and ethyl chloride with no additives. Only slight effect of pressure (in the range of 200–500 mm Hg) was found for irradiated methyl chloride, while apparent increase of the yield of some simple ^{35}S-labeled compounds appeared in ethyl chloride under the same conditions. The reactions of recoil ^{35}S atoms with gaseous methane were examined in detail. For this purpose, the methane-hydrogen chloride mixture with additives were irradiated under the constant conditions. Argon and nitric oxide were used as moderator and scavenger, respectively. The composition of irradiated samples varied in the range of 20–260 mm Hg of methane and argon, 0.02–12 mm Hg of nitric oxide, the partial pressure of hydrogen chloride keeping constant (100 mm Hg). The ^{35}S-labeled hydrogen sulfide and methyl mercaptan were found as main products in irradiated samples. The results obtained show that the yield of hydrogen sulfide is mostly affected by the concentration of nitric oxide. On the other hand the amount of methyl mercaptan formed is determined mainly by the concentration of argon. (auth)

13496 MASS SPECTROMETRIC STUDIES OF REACTIONS OF RECOIL IONS WITH MOLECULES. S. Wexler (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/69, 39p. (CONF-773-11).

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Mechanisms of the reactions of recoil species from nuclear transformation have previously been inferred from the distribution of the stable products. Two alternate experimental approaches, which use mass spectrometric techniques to identify the transient ionic intermediate products of recoil reactions, are described. These experiments provide a direct study of modes of energy loss by high-energy tritium recoils during slowing down to the range of chemical reaction energies; and evidence for the mechanism of the chemical reaction with CH_4 of the low-energy $(T^3He)^+$ daughter from β^- decay of T_2. Ionic products from interactions of 0.8–3.75 Mev protons (as stand-ins for tritons) with several isolated noble gas atoms and hydrocarbon molecules (methane, acetylene, ethylene, ethane, propane, and n-butane) were observed in a portable mass spectrometer with special constructional features. Species in various charge states were produced from the noble gases. Partial ionization cross sections determined for the individual charge states varied between 10^{-18} and 10^{-20} cm^2 $molecule^{-1}$. Collision of a proton with a polyatomic hydrocarbon molecule resulted in ionization and extensive fragmentation. Only singly-charged fragments were found. Comparisons were made with the effects provoked by high energy electrons with the same velocity as that of the protons. The results show that energetic tritium recoils from the ^3He (n,p) T and ^6Li (n,α) T nuclear reactions must lose kinetic energy through inelastic ionizing and exciting collisions with the medium, and that the recoils behave much like any ionizing agent. Consequences of these processes in hot atom chemistry are discussed. (P.C.H.)

13497 THE EFFECT OF COMPRESSION ON THE ANNEALING BEHAVIOUR OF NEUTRON-IRRADIATED POTASSIUM DIHYDROGEN ARSENATE CRYSTALS. V. Kacena and A. G. Maddock (Cambridge Univ., Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/63, 15p. (CONF-773-18)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The annealing behaviour of ^{76}As atoms (from (n,γ) reaction) and ^{74}As atoms (from (n,2n) reaction) in neutron (slow and fast) irradiated potassium dihydrogen arsenate crystals with and without compression was studied. The distribution of radioactive arsenic atoms between tri- and pentavalent form was determined either by paper electrophoresis in 0.01M sodium hydroxide solutions (for slow-neutron-irradiated samples) or by gravimetric method as magnesium pyroarsenate (for fast-neutron-irradiated samples). No essential difference was found in annealing behavior of ^{74}As and ^{76}As atoms both without and with pressure treatment, when paraffin oil was used as pressure transmitting medium. When irradiated samples were compressed without paraffin oil, there was an increase in the content of the pentavalent form of arsenic as long as the pressure was applied before the pseudo-plateau for the given temperature was reached. The amount of the change was not dependent on the value of pressure applied, once the threshold value was applied. The effect was explained in terms of defects produced by slipping of dislocation lines, caused by anisotropic compression, when the pressure was applied without the paraffin oil as medium. (P.C.H.)

13498 THE CHEMICAL CONSEQUENCES OF THERMAL NEUTRON CAPTURE IN SOLIDS. J. I. Vargas (Universidade de Minas Gerais, Brazil). 67p. (IPR-43; CONF-631104-2)

From Meeting on the Utilization of Research Reactors, São Paulo, Brazil.

This review deals specially with the chemical consequences of the reaction induced by thermal neutrons in solids. The production of radioisotopes by the Szilard-Chalmers technique is also briefly considered, mainly from the point of view of isotope production in low flux reactors. (auth)

13499 RECOIL PROCESSES OF Cr-51 IN MIXED INORGANIC SYSTEMS. S. R. Veljkovic, S. M. Milenkovic, and M. R. Ratkovic (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia and Faculty of Natural Sciences, Belgrade). Vienna, International Atomic Energy Agency, 1964, Preprint No. 57/42, 12p. (CONF-773-27)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The effects of neutron irradiation were studied in mixtures of chromates or chromi salts and inorganic oxides. Alumina, SiO_2, and MgO were used. Thermal effects were parallelly controlled to evaluate the purely thermal effects in the reactor and to estimate possible internal heating in the targets. The system where chromates were deposited on the MgO showed an extensive reduction to chromi ion. The neutron effects exceed the thermal processes at the irradiation temperature, and only heating above 600°C had similar tendencies. Chromi ion did not change during the irradiation. An increase in the concentration of the chromates gave well-known retention of $^{51}CrO_4^{2-}$. The chromates adsorbed on alumina preserved oxy-form, the same as in the system with SiO_2. The thermal effects had the same direction. Chromi ion adsorbed on these oxides behaved differently. In the system with alumina, extensive oxidation was noted, which considerably exceeded the thermal processes. A small difference was found in the system with SiO_2, when irradiation and heating were compared, although an extensive diffusional impoverishment of chromi ion on the surface was noted. It was concluded that the crystal lattice of the oxides and thermal effects exert an extensive influence in the systems. (P.C.H.)

13500 RETENTION IN SOLID KIO_3, ACTIVATED WITH FAST AND SLOW NEUTRONS. A. H. W. Aten, Jr., M. Lindner-Groen, and L. Lindner (Instituut voor Kernphysisch Onderzoek, Amsterdam). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/31, 10p. (CONF-773-17)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Primary (unannealed) retention was studied in solid KIO_3 activated by means of fast and thermal neutrons. With fast neutrons the retention of ^{128}I was appreciably higher than

that of ^{126}I but the retention of ^{128}I obtained with thermal neutrons was even higher than that obtained with fast neutrons. This indicates that apart from the decay scheme the recoil energy may also constitute a factor determining the retention. The annealing of ^{128}I and ^{126}I (both obtained with fast neutrons) also proved to be different. Under post-irradiation treatment at temperatures up to 100°C the retention of both isotopes increased by the same percentage of the total activity, i.e. the difference in retention remained constant. Thus the fraction of the ^{126}I which is reduced by the recoil process in excess of the reduced fraction of ^{128}I, is much less affected by heating than the fraction that is reduced in both isotopes. It was evident that such a complicated chemical behavior of the radioactive recoil atom can only be explained by a fairly detailed model. (P.C.H.)

13501 RESEARCH IN RADIOCHEMISTRY, PHYSICS AND NUCLEAR CHEMISTRY AT THE INSTITUTO DE PESQUISAS RADIOACTIVAS. J. I. Vargas (Universidade de Minas Gerais, Brazil). 29p. (IPR-45; CONF-631104-3)

From Meeting on the Utilization of Research Reactors, São Paulo, Brazil.

Some results of investigations carried out at the Instituto de Pesquisas Radioativas are discussed. Broadly speaking, these researches deal with physico-chemical problems associated with radiation damage in solids. As a by-product of these studies interesting properties of substances which might serve for dosimetric purposes have been explored. Some of the investigations reported are subsidiary to an understanding of the physico-chemical phenomena pertaining to the hot atom chemistry. (auth)

13502 THE MECHANISM OF THERMAL ANNEALING IN SOME NEUTRON IRRADIATED COBALT COMPLEXES. A. G. Maddock, A. B. J. B. Todesco, and D. Blaxell (Cambridge Univ., Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/41, 31p. (CONF-773-33)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Kinetic studies of the individual steps in thermal annealing reactions were carried out using trinitrotriammine cobalt III, trans dinitrotetra-ammine cobalt III trans tetranitrodiamminocobaltate III, cis dinitrotetra-ammine cobalt III trans tetranitrodiammine cobaltate III, trans dinitrotetra-ammine cobalt III nitrite, and ammonium trans tetranitrodiamminecobaltate III. The purity of the initial materials and the distribution of the products were determined by paper electrophoresis. The results obtained do not support a sequential mechanism in these systems. Rather do they agree with previous observations on the stereo-specificity of the annealing reactions and seem to suggest a one step mechanism whereby the original complex is reformed. Some of the consequences of such a model are considered and correlated with the data obtained. (P.C.H.)

13503 CHEMICAL EFFECTS FOLLOWING THERMAL NEUTRON CAPTURE IN POTASSIUM CHROMATE. T. Andersen and K. Olesen (Aarhus Universitet, Denmark). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/10, 27p. (CONF-773-21)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

A new analytical method, based on the slow rate of exchange between chromo and chromic ions, was used to show that more than 90% of reduced chromium ions are present in the 2+ valence state. The results obtained, using the new analytical method, indicate that the processes taking place during solution are hydration processes while the reduction of chromium fragments takes place in the crystal. Isothermal and isochronal annealing experiments carried out on crystals irradiated at room temperature show that three annealing reactions occur between 60 and 275°C. The influence of quenching and foreign ions on the three annealing reactions was studied. Investigations made in parallel of chemical changes of ^{51}Cr recoil species and electronic changes in irradiated potassium chromate during post-irradiation treatment were carried out measuring the thermoluminescence spectrum, the electrical conductivity, and the chemical distribution of ^{51}Cr fragments. The results show that two of the chemical annealing reactions are associated with electronic changes indicating a close relation between chemical annealing and the disappearance of color centers. (P.C.H.)

13504 THE CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS IN THE ALKALI CHLORIDES. PART I. FACTORS DETERMINING THE BEHAVIOUR OF THE S^{35}. A. G. Maddock and R. M. Mirsky (Cambridge Univ., Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/40, 36p. (CONF-773-20)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Studies were made on the $^{35}Cl(n,p)^{35}S$ reactions in alkali chlorides. A survey of the main features of the behavior of the ^{35}S is also included. Crystals of sodium and potassium chlorides bombarded with 2 Mev electrons, in doses varying from 0.1 to 150 mRad, prior to neutron irradiation, all showed a great increase in the proportion of ^{35}S precipitating as sulfide. In sodium chloride more than 90% precipitates as sulfide at a dose of 50 mRad. An increase was also seen when sodium chloride crystals were enriched with sodium by heating in the metal vapor, and when small amounts of divalent calcium and cadmium were introduced into potassium chloride crystals. All these three treatments involve the introduction of defects into the crystal lattice, so these are presumed to play a determining role in the final state of the ^{35}S produced. The sulfide fraction present in electron-bombarded crystals, and crystals containing divalent substituted ions, was less stable than the same fraction in untreated crystals. The crystals became colored on neutron irradiation due to the formation of F and V centers. If the centers were bleached by heat or exposure to daylight, a small increase in the sulfide fraction was seen in sodium and rubidium chlorides. Vacuum outgassing of crystals before neutron irradiation seemed to have no effect on the proportion of sulfide found. A preliminary interpretation of the data is given and it is shown that there is no necessity to invoke improbably highly positively charged sulfur species. (P.C.H.)

13505 POST-IRRADIATION BEHAVIOUR OF ^{131}I IN TeO_2. Lj. Jacimovic, J. Stevovic, and S. R. Veljkovic (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia and Faculty of Natural Sciences, Belgrade). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/44, 18p. (CONF-773-9)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Radioiodine was produced by neutron irradiation of TeO_2 in the reactor. Irradiated TeO_2 was dissolved in dilute NaOH, and analysis of the iodine valency forms was made by ion exchange techniques. The thermal and radiation stability of TeO_2 was studied by using the spectrophotometric method for the determination of tellurium. Post-irradiation annealing of ^{131}I in TeO_2 was studied in dependence on the time and temperature of the heating. The main tendency of annealing was the reduction of radioiodine. The time dependence of this process indicated a fast change at high temperatures. The annealing may appear complex because of the variety of thermal reactions of iodine intermediary. It may react with products of the following processes: tellurium recoil and corresponding hot zone; beta transition of ^{131}Te; and TeO_2 itself. The kinetics of these changes was considered and an estimation of the processes during annealing was made. The influence of the neutron flux on the kinetics of annealing was also studied. (auth)

13506 EFFECT OF OUTER IONS ON THE SEPARATION OF THE Br^{80} NUCLEAR ISOMERS IN SOLID

$[M^{III}(NH_3)_5Br]$ (anion^I)$_2$ AND (cation^I)$_2$ $[M^{IV}Br_6]$ COMPLEXES. G. B. Schmidt and W. Herr (Universität, Cologne). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/17, 17p. (CONF-773-31)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The influence of the outer anions and cations, respectively, on the percentage of separable $^{80g}Br^-$-ions, following the isomeric transition, was investigated in the solid ^{80m}Br-labeled pentamminebromo complexes of Co, Rh, and Ir and hexabromo complexes of Re and Os. By substitution of ammonium in $(NH_4)_2[ReBr_6]$ by alkylammonium groups, the $^{80g}Br^-$-yield increases with the size of the alkyl group. In the pentamminebromo complexes of Co, Rh, and Ir, the $^{80g}Br^-$-yield is strongly dependent on the chemical nature of the anion and/or the physical properties of the crystals. The $^{80g}Br^-$-yields of 12 different $[Ir(NH_3)_5Br]X_2$ complexes lie between 77% ($X = NO_3^-$) and 41% ($X_2 = C_2O_4^{--}$) at 20°C. Anions with reducing properties may favor intramolecular charge neutralization and show therefore lower $^{80g}Br^-$-yields, anions with oxidizing properties result in higher values of $^{80g}Br^-$. Also the annealing behavior of the ^{80}Br daughter atom was studied in these compounds. In $[M(NH_3)_5Br](NO_3)_2$ crystals the $^{80g}Br^-$-yields are constant over a certain range of temperature; but above characteristic temperatures annealing of the ^{80g}Br atoms or ions occurs in the normal way. In contrast, the analogous $[M(NH_3)_5Br]Nr_2$ and $[M(NH_3)_5Br]Cl_2$ crystals show increasing $^{80g}Br^-$-yields with rising temperature. In this case a limiting yield of 66% was observed, indicating that activated exchange reactions occur between complex-bound bromide and ionic bromide or chloride. Some alkyl ammonium hexabromo complexes show no annealing of the differentiated daughter atoms. In anionic ^{80m}Br-labeled Rh- and Ir-pentammine acido bromides, 9-18% of the ^{80g}Br daughter atoms are capable of substituting co-ordination groups. These yields are independent of temperature, pointing out that substitution reactions of ligand groups occur only by hot atom processes. The results give some indication of the reaction zone of the I.T. nuclear process. (auth)

Radiochemistry

Refer also to abstracts 13281, 13486, and 13871.

13507 (UJV-1165/64) METOD OPREDELENIYA SODERZHANIYA ^{60}Co V RASTVORAKH ^{59}Fe BEZ NOSITELYA. (Determination of ^{60}Co in Carrier-Free ^{59}Fe Solutions). V. Kachena (Československa Akademie Věd. Ústav Jaderného Výzkumu, Řež). 1964. 11p. Dep.(mn).

Preparation of carrier-free ^{59}Fe is discussed. Results and procedures for ^{60}Co separation from carrier-free ^{59}Fe by substechiometric methods are given. (R.V.J.)

13508 MEASUREMENT OF BETA ACTIVITIES IN AQUEOUS SPECIMENS USING ČERENKOV RADIATION. K. Haberer (Technische Hochschule, Karslruhe, Ger.). Atomwirtschaft, 10: 36-43(Jan. 1965). (In German)

The measurement and application of radionuclides frequently suffer because the beta radiation from aqueous media can only be assessed with very low efficiency. The water layer used for measurement can only be a few millimeters thick because of the high self-absorption. For this reason beta emitters in general can be directly evaluated in aqueous specimens only when high specific activities are involved. The usual methods for measuring beta activity of aqueous specimens by evaporation is accompanied by losses through adsorption on the vessels and because of the volatility of many compounds. In addition preparation of the specimens is generally relatively time consuming. To circumvent these disadvantages methods are being investigated whereby small specific activities in aqueous specimens can be assessed using the Cherenkov radiation produced by beta emitters of not too low an energy. Cherenkov radiation is emitted if particles traversing matter have a velocity greater than the velocity of light in the same medium. In the case of water as the optically denser medium electrons must have a minimum energy of 260 kev in order to excite Cherenkov radiation. In the case of beta emitters the maximum energy must clearly exceed this value because of the wide energy distribution. The investigations described for the assessment of hard beta emitters using Cherenkov radiation and a commercially available liquid scintillation counter showed that under optimum conditions very high measurement sensitivities could be obtained. The advantages of this direct measurement of aqueous specimens using Cherenkov radiation are that it requires practically no prior preparation of the specimens, it does not suffer from losses due to self-absorption, the measurement conditions are fixed, the specimens can easily be transported, and the specimens can be used for other investigations after measurement. A further increase in measurement accuracy beyond that attained in the investigations described may be achieved by increasing the volume of the specimens. (auth)

13509 AN ESTIMATION OF THE INHERENT ACCURACY OF THE TRACER TECHNIQUE FOR MEASUREMENTS OF DISINTEGRATION RATE. A. Williams (National Physical Lab., Teddington, Middx., Eng.). Intern. J. Appl. Radiation Isotopes, 15: 709-12(Dec. 1964).

The tracer method of measuring the disintegration rate of a β-emitting nuclide assumes that there is a linear relationship between the β-efficiencies of the tracer and β-emitter for quite a large range of efficiencies. This assumption is considered in detail and a method is given for estimating the error it introduces. (auth)

13510 PRODUCTION OF CARRIER-FREE FLUORINE-18. C. C. Thomas, Jr., J. A. Sondel, and R. C. Kerns (Western New York Nuclear Research Center Inc., Buffalo). Intern. J. Appl. Radiation Isotopes, 16: 71-4(Feb. 1965).

A rapid and effective procedure for the preparation of carrier-free fluorine-18 is described. The ^{18}F was produced by neutron irradiation of lithium carbonate and was separated by dissolving the material in acid and distilling off the hydrogen fluoride solution. The yield is better than 70%, radioactive impurities less than 2 ppm, and the residual tritium content is less than 0.22 mC. (auth)

13511 THE EXPOSITION OF ISOTOPE EFFECTS ON RATES AND EQUILIBRIA. Maurice M. Kreevoy (Univ. of Minnesota, Minneapolis). J. Chem. Educ., 41: 636-8(Dec. 1964).

Two formulations of the theory of isotope effects are pointed out: the physical formulation; and the organic formulation. An approach to this subject is presented that avoids conceptual error, and permits correct qualitative conclusions to be reached from available data. The example is taken of the difference between the ionization constant of acetic acid in water and that in heavy water, a manifestation of Heisenberg uncertainty principle which can be detected with a pH meter. Classically there is no effect predicted; in fact, K_H/K_D is 3.3. The origin of the effect is illustrated, in which a one-dimensional version of the real multi-dimensional explanation is given. The generalization is made that, in a system where protons and deuterons are allowed to equilibrate among a number of different positions, deuterons tend to accumulate in those positions where they are most closely confined by potential barriers. The hydrogen isotope effect on an equilibrium constant, K_H/K_D, is given in terms of one equation and that on a rate constant, k_H/k_D, by another equation. These equations serve to point up the importance of zero-point vibrational energy in determining isotope effects, and, in cases where the necessary vibrational frequencies are known, they can be used for the quantitative estimation of such effects. Primary kinetic isotope effects are explained and secondary kinetic isotope effects are formulated in the same way as isotope effects on equilibria. An example is furnished by the recent finding that the racemization of 2,2'-dibromo-4,4'dicarboxy-6,6'-

dideuterobiphenyl is faster than that of the undeuterated analogue. This approach is readily generalized to isotope effects involving atoms other than hydrogen. Its qualitative conclusions generally remain unchanged if the partition function and transmission coefficient terms are included in the two equations presented. (TCO)

13512 MASS TRANSPORT OF URANIUM BY FISSION FRAGMENTS. M. D. Rogers (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 15: 65-72(1965). (AERE-R-4639)

The mechanisms involved in the mass transport of uranium by fission fragments were studied by electron microscopy and alpha spectroscopy. It is shown that displacement spikes involving about 10,000 atoms are probably responsible for the ejection of particles from a uranium metal surface. When these particles are collected on a surface placed near the uranium surface they are vaporized when ionization occurs due to the passage of a fission fragment. (auth)

13513 STUDY OF AN EMANATING SOURCE (PRODUCTION OF RADON). W. Singer (Universite, Libre, Brussels). J. Phys., Phys. Appl. (Paris), 25: 189A-93A (Nov. 1964). (In French)

The behavior of a solid emanating source of 50 mC, precipitated from $RaCO_3$ on $Fe(OH)_3$, was compared with that of an acid solution of $RaBr_2$. The radon yield of the solid source decreased from 86 to 70% in six months and stabilized at the 70% level. The initial volume of gas was reduced to about 20 mm^3/50mC after passage through a purification chamber containing Cu–CuO at 400°C and some artificial zeolites (Linde Molecular Sieves). (D.C.W.)

13514 EXPERIENCES ON Cr^{51} ENRICHMENT BY SZILLARD-CHALMERS EFFECT. J. Toerkoe (State Atomic Energy Commission, Budapest). Kernenergie, 7: 753-56(Nov. 1964). (In German)

The enrichment of Cr_{51} by means of the Szillard-Chalmers effect using chromium complexes, organic chromium compounds and chromate salts as targets is reported. Potassium chromate was found to be the most effective agent. Compiled and tabulated data show the generated activity, separated activity, retention, Cr-content, specific activity and the coefficient of enrichment for this material as function of irradiation time. The experimental procedure is described and the results are discussed. (OTS)

13515 DETERMINATION OF ABSOLUTE ACTIVITY AND ENERGY OF BETA-EMITTING NUCLIDES WITH LIQUID SCINTILLATORS. Klaus E. Duftschmid. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 10, 170-86(1963). (In German)

A device was built for determination of the absolute activity and spectrometry of β-emitting nuclides dissolved in liquid scintillators. The "integral-extrapolation" method for the measurement of absolute beta activities is described, and its absolute accuracy confirmed by comparison with international standards. Use of liquid scintillators in beta spectrometry was also studied. By introduction of a very advantageous energy calibration with the help of the Compton effect, which was verified by calculation of Curie diagrams, it could be shown that the liquid scintillator makes possible a simple determination, free of self-absorption, of the maximum β energy in 4-π geometry with very satisfactory accuracy. (tr-auth)

13516 PROTEIN LABELLING WITH RADIOIODINE BY ELECTROCHEMICAL WAY. NOTE I. IODINATION OF TYROSINE. C. Ambrosino, J. Liberatori, U. Rosa, G. A. Scassellati, and F. Pennisi (Universita, Turin and SORIN, Saluggia, Italy). Ric. Sci., Rend., Sez. B (2), 4: 669-80 (June 1964).

In order to obtain labeled proteins that are homogeneous from a physical and chemical point of view and unchanged, as far as their biological specificity is concerned, an electrochemical iodination method was studied, consisting in the electrolysis, in a suitably designed cell, of an aqueous solution of protein, and ^{131}I-tagged potassium iodide. Such a method, not requiring chemical oxidizing agents and enabling the formation rate of elemental iodine to be controlled in the solution containing the protein, should reduce the extent of the unwanted side effects. An extensive study of the problems connected with protein iodination calls for a preliminary investigation into the iodination conditions of some fundamental amino acids. The purpose of this work is to study the electrolytic iodination of tyrosine under experimental conditions considered suitable for the labeling of plasma proteins. Using an electrolytic cell, fed at a constant current by means of a coulometer, the iodination of tyrosine solutions was studied at an initial concentration of 2.5×10^{-3}M; this value approximately corresponds to the maximum reactive tyrosyl groups of the solutions, at plasmatic concentration, of the most important serum proteins. By employing KI tagged with ^{131}I, it was possible to follow the iodination process and to evaluate, by radiochromatography, the relative amounts of mono- and di-iodotyrosines (MIT and DIT) formed. Studying the reaction at different values of the electrolysis current, it has been established that, under our experimental conditions, the iodination is complete for current values not higher than 1 ma and for tyrosine concentrations not lower than 3.5×10^{-4}M. These results confirm that the chemical iodination methods, by which the iodine is set free very rapidly, will promote the buildup of elemental iodine in the solution, favoring the side reactions. Moreover, it has been established that the electrolytic iodination method allows KI solutions of concentration as low as 2.5×10^{-5}M to be employed, with discharge yields practically quantitative: it is therefore particularly suitable for getting products of high specific activity and low iodination degree. The iodination is still possible for a KI concentration as low as 0.5×10^{-5}M, which is practically that of ^{131}I carrier free solutions. The results, although obtained under extremely simplified conditions, have proved to be very useful in some preliminary experiments on the iodination of serum albumin, whose accessible tyrosyl residues maintain, as is well known, a high reactivity towards iodine. (auth)

13517 CHEMICAL EFFECTS OF BETA-DECAY OF A LANTHANIDE ATOM COMPLEXED WITH AMINO-POLYCARBOXYLIC ACID CHELATING LIGANDS. P. Glentworth and B. Weseall (Leeds Univ., Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/37, 37p. (CONF-773-15)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The effects of beta decay of lanthanide atoms were investigated in a series of amino- polycarboxylic acid complex ions, which were chosen because they form multidentate chelated complex ions of exceptionally high stability. The effects of beta decay of a lanthanide atom complexed with a multidentate ligand would be either to provide sufficient energy to disrupt the molecule and produce the daughter atom in the uncomplexed, or free-ion form, or to produce an energetically excited species capable of undergoing exchange reactions at an enhanced rate. In order to correct for the contributions of thermal exchange reactions to the observed effects of beta decay it was necessary to determine the rates and establish the mechanisms of exchange reactions between cerium ions (Ce^{3+}) and a series of cerium complex ions of the general formula $(CeY)^{n-}$; where Y was ethylenediaminetetraacetic acid (EDTA); diethylenetriaminepentaacetic acid (DTPA) and trans 1.2-diaminocyclohexanetetraacetic acid (DCTA). It was found that beta decay of a lanthanide atom complexed with an amino-polycarboxylic acid chelating ligand results in the break-up of the complex ion in a surprisingly high percentage of beta decays. In aqueous solution break-up was found to occur in 30 to 85% of all beta decays depending on the nature of the complexing ligand and on the energy available for the beta decay process. Two beta decay processes were studied with quite different beta-particle energies. Deductions concerning the mechanisms for break-up of the complex ions were made in terms of unstable excited intermediate species and were based on the effects of variation of hydrogen

ion concentration, temperature, and ionic strength of the aqueous solutions on the percentage break-up of the complex ion. (P.C.H.)

13518 MÖSSBAUER EFFECT STUDY OF THE ISOMERIC DE-EXCITATION IN Sn^{119m}. R. H. Herber and H. A. Stoeckler (Rutgers Univ., New Brunswick, N. J.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/80, 20p. (CONF-773-16)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Three major chemical effects of nuclear transformations were investigated by Mössbauer techniques in stannic oxide, metallic (grey) tin, and tetraphenyl tin, each labeled with the nuclide ^{119m}Sn. These chemical effects are: consequences of the $^{118}Sn(n,\gamma)^{119m}Sn$ process and effects of the concomitant gamma radiation during pile exposure; recoil effects accompanying the M4 decay; and effects of internal conversion of the M4 decay. In $^{119m}SnO_2$, neither the gamma radiation exposure during pile irradiation, nor the emission (and internal conversion) of the 65.3 kev radiation led to observable changes in the resonance line shape or position. In both cases two oxidation states of the metal oxide are known [Fe(II), Fe(III) and Sn(II), Sn(IV), respectively] but only in the case of ^{57}CoO was the presence of both states observed. Similar negative results were obtained in metallic (grey) tin, in consonance with the observations on ^{57}Co diffused into metallic iron and used as a Mössbauer source. As in the case of ^{57}Co-labeled cobalticinium tetraphenyl borate, however, the chemical consequences of nuclear de-excitation were observed in metal-organic compounds labeled with ^{119m}Sn. When $^{119m}Sn\phi_4$ was used as a source at 78°K with a 17 mgm cm^{-2} SnO_2 ceramic absorber, the major resonance was that associated with the single non-quadrupole split resonance line observed with an unlabeled $Sn\phi_4$ absorber. In addition there was a contribution to the resonance pattern by a broad line (or quadrupole split resonance) absorption which reflects the filling of K or L shell vacancies by valence electrons. Direct bond rupture due to recoil was excluded from giving rise to this effect since (in the nonrelativistic approximation) the recoil energy must be less than ~0.3 kev (~7 k cal. $mole^{-1}$), which is well below the chemical bond energies involved. (P.C.H.)

13519 PRODUCTION OF XENON COMPOUNDS BY THE BETA DECAY OF IODINE IN IODINE COMPOUNDS. G. J. Perlow and M. R. Perlow (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-57/83, 27p. (CONF-773-10)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Beta decay $^{129}I-^{129}Xe$ in an iodine compound was studied by use of the Mössbauer effect in ^{129}Xe. In the first experiments a source of ^{129}NaI was used with absorbers of hydroquinone clathrate, Na_4XeO_6, XeF_4, and XeF_2. Single line spectra were observed for the clathrate and pexenate and two line spectra for the fluorides. The single line indicates that in the source $I^- - Xe^0$, its iso-electronic daughter. When $Na_3H_2IO_6$ was used as source, with clathrate absorber, the recoilless fraction increased by a factor of 3, implying stronger bonding. KIO_4 also gave a single but somewhat less intense line. With $NaIO_3$ as source and clathrate absorber, splitting was observed suggesting that $IO_3^- - XeO_3$. This was verified by the observation of identical splitting in an XeO_3 absorber used with KIO_4 source. An experiment with $KICl_4 \cdot H_2O$ as source and clathrate absorber showed splitting somewhat smaller than in XeF_4. Here $ICl_4^- - XeCl_4$. Using aligned crystals of $KICl_4 \cdot H_2O$ and making quantitative intensity measurements, it was established that the square planar structure of ICl_4^- is preserved in the transition to $XeCl_4$ and that $XeCl_2$ and Xe^0 are not formed in the reaction in detectable amounts. With $Na_3H_2{}^{131}IO_6$ as source the effect was observed in ^{131}Xe. Comparing XeF_4 spectra in both isotopes calibrated the splitting in ^{129}Xe and enabled quantitative comparison of XeF_4 and $XeCl_4$ with ICl_4^-, and of XeO_3 with IO_3^-. The unsplit KIO_4 spectrum implies that the tetrahedral ligand environment of the iodine is preserved in the resulting XeO_4. Similarly, the paraperiodate result is consistent with preservation of its octahedral environment. (P.C.H.)

13520 METHOD OF REMOVING RADIOACTIVE PRODUCTS FROM AN ORGANIC MODERATOR-COOLANT USED IN A NUCLEAR REACTOR. James F. Black (to Esso Research and Engineering Co.). U. S. Patent 3,161,599. Dec. 15, 1964. Filed Apr. 16, 1962.

A method of removing radioactive ^{35}S and ^{32}P from a liquid aromatic hydrocarbon moderator-coolant is reported. The method consists primarily of reacting the ^{35}S and ^{32}P with a strongly basic material such as an alkali metal oxide or hydroxide. The ^{35}S and ^{32}P are associated with a high-boiling polymeric material formed by the thermal and radiation effects on the hydrocarbons; the polymer and accompanying radioactive materials may be separated by conventional chemical means prior to being reacted with the basic material. This treatment is reported to reduce the ^{35}S content in a side stream of the moderator-coolant from a level of ~2 mC/cc to ~0.01 μC/cc; likewise the ^{32}P was reduced from ~5.57 mC/cc to ~0.01 μC/cc. The separated radioactive products may be further concentrated for final disposal. (A.G.W.)

Separation Processes and Procedures

Refer also to abstract 14765.

13521 (CONF-631201(p.41-6)) PROCESSING SPENT MATERIALS. Myron C. Beekman (Detroit Edison Co., Detroit).

The chemical processing of spent reactor materials on a commercial basis is considered. The AEC hypothetical plant, the Industrial Reprocessing Group, the Nuclear Fuel Services (NFS) reprocessing facility, AEC-NFS contract provisions, NFS-Utility contract provisions, and future processing plants are discussed. (C.E.S.)

13522 (EUR-2191.n) DUNNELAAGCHROMATOGRAFIE VAN POLYFENYLEN OP BENTON. (Thin-Layer Chromatography of Polyphenyls on Bentone). F. J. Ritter, G. M. Meyer, and F. Geiss (Netherlands. TNO. Centraal Laboratorium, Delft). 1964. 12p. (CONF-640911-1). Dep.(mn).

From Symposium on Chromatography, Brussels.

Bentone is a useful material for the separation of polyphenyls by thin-layer chromatography. For coating the plates it is necessary to add celite to the bentone. Chromatography was studied in biphenyl, 3 terphenyls, 9 quaterphenyls, some quinquephenyls, anthracene, phenanthrene, and triphenylene where n-heptane is used as solvent. By repeated treatment, the separation is improved and reaches its optimum after three runs. After comparing these results with the more classical materials like aluminium oxide, it seems that the R_f-values on bentone depend more upon structure (ortho, meta, and para) and less upon molecular weight. Phenanthrene, which gives trouble in the quantitative determination of terphenyls on aluminium oxide can be separated very well on bentone 38. Chromatography on bentone 38 may be regarded as a good supplementary method to that on alumina. (auth)

13523 (EUR-2199.e) ELECTRODIALYSIS AS AN AUXILIARY IN THE SEPARATION OF Cs AND Sr FROM ACID FISSION PRODUCT SOLUTIONS. A. Guery and L. H. Baetsle (Centre d'Étude de l'Énergie Nucléaire, Mol, Belgium). 1964. 13p. Dep.(mn).

A study was performed on the use of electrodialysis as a means for deacidulation and desalination of high level reprocessing waste solutions. Two types of electrodialysis cells were investigated: the two- and three-compartment cells. Despite the simplicity of the first type, it proved to be inadequate for deacidulation purposes because of the high ammonia formation in the catholyte which impedes

subsequent ion exchange processes. A three-compartment cell turned out to be much more suitable if the feed solution does not contain appreciable amounts of salts. In the latter case, an amount of phosphoric acid equivalent to the total amount of bulk ions has to be added in order to avoid precipitation in the feed compartment. A special electrodialysis cell was designed for the desalination of ammonium nitrate solutions being used as elutriant for Cs from mineral ion exchangers. The feed solution is brought into the cathode compartment and the semi-permeable membrane is made of fired clay. The passage of current through this membrane with high electrical resistance, carries nitrate ions and heats the cell leaving an ammonia solution which evaporates. (auth)

13524 (HW-81984(p.4.1-20)) CHEMICAL RESEARCH AND DEVELOPMENT. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Engineering development of a salt cycle recovery process in reported. In cold pilot plant experiments unirradiated U was used as feed in support of C-cell effort with identical equipment. Other research is reported on liquefaction of off-gas Cl_2, dissolution of PRTR UO_2-PuO_2 fuels, chloride contamination of electrolytic UO_2, chemistry of U and Pu in chloride melts, and electrochemistry of molten chloride salt solutions. Research on residue process development was continued with high-livel radiochemistry facility studies, laboratory studies, and cold semiworks studies. (J.R.D.)

13525 (KFK-216) UNTERSUCHUNGEN UBER DEN ANIONENAUSTAUSCH AN EISENHYDROXID. (Investigation of Anion Exchange on Iron Hydroxide). Ludwig Lindner (Kernforschungszentrum. Institut fur Radiochemie, Karlsruhe, Germany). May 1964. 88p. Dep.(mn).

The behavior of the anions chloride, nitrate, iodide, pertechnetate, molybdate, tellurite, tellurate, phosphate, and the monovalent cations Cs and Na with respect to iron hydroxide was investigated with radioactive tracers. The results showed the isoelectric point (IEP) of the compounds tested on pseudomorphic iron hydroxide was found at pH 7.1 to 7.2. Chloride, nitrate, iodide, and pertechnetate anions were retained only for pH < IEP. The cations Cs and Na were practically unretained for pH < IEP, but strongly held for pH > IEP. The IEP for the polyvalent anions molybdate, tellurite, and tellurate had no significance. These ions were deposited at pH > IEP. Molybdate was fixed on iron hydroxide both as the molybdate monomer and as the hexamolybdate. The shaking of iron hydroxide with molybdate solutions at 3 < pH < 5 resulted in the dissolution of iron. At 3 < pH < IEP or 3 < pH < 12, a simple rapid separation of the daughters in the $^{99}Mo/^{99m}Tc$ or $^{132}Te/^{132}I$ systems could be obtained. (tr-auth)

13526 (KY-L-379) FLUID BED ASH RECOVERY. Paducah Plant Laboratory, June–August 1961. (Paducah Gaseous Diffusion Plant, Ky.). Dec. 30, 1964. Contract [W-7405-eng-26]. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A system for recovering uranium from ash expected to be generated from a CaF_2-diluted fluid-bed fluorinator is studied. Since consideration of a fluid-bed fluorinator was subsequently dropped, detailed studies of the ash recovery system were not made. The information on ash recovery is presented. (N.W.R.)

13527 (LADC-6297) PROCESSING OF PLUTONIUM BY ION EXCHANGE. III. KINETIC AND EQUILIBRIUM PARAMETERS FOR THE CALCULATION OF FIXED-BED COLUMN PERFORMANCE. D. B. James and R. S. Cooper (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Parameters and equations are presented which allow the numerical duplication of the sorption of plutonium on nitrate-form Dowex 1 × 4 from 7 M nitric acid. A mass-action description of the two-phase equilibria and an empirical expression for the sorption rate are coupled with the fundamental partial differential equation which describes the operation of a fixed-bed ion-exchange column to produce a system that is only numerically solvable. The calculation and experiment are in good agreement. (auth)

13528 (NLCO-940(p.5.1-9)) THE CHEMICAL SEPARATION OF RARE EARTHS FROM URANIUM—A RADIOACTIVE TRACER EVALUATION. G. R. Blank, B. L. Twitty, and W. H. Dingeldein (National Lead Co. of Ohio, Cincinnati).

An anion exchange separation method was developed and evaluated with radioactive tracers. This method permits the rapid, quantitative separation of microgram quantities of rare earth elements from 5 g of uranium. Cerium, europium, uranium, and occasionally thorium were used as tracers. Compared with solvent extraction, the anion exchange method is expected to reduce by 50% the time required to separate rare earths from uranium for spectrochemical analysis. (auth)

13529 (NP-14593) CRITICALLY SAFE MIXER-SETTLERS. J. Centeno (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Mar. 1962. 25p. (ETR-138(Rev.)) Dep.(mn); $2.00(cy), 1(mn) OTS.

A review of the most suitable types of mixer-settlers for processing concentrated solutions of fissionable materials is presented. The essential characteristics of the different types of extractors are compared. Critically safe design, efficiency prediction, and scaling-up methods are also considered. The horizontal slab type (stages assembled side by side) and turbine type (in-line assembly) mixer-settlers seen to be the most suitable as "ever safe" extractors. For ease of maintenance, the air-pulsed mixer-settler should be one of the types to be considered. (auth)

13530 (NP-14770) REPORT ON PILOT PLANT FLOTATION OF URANIUM ORE FROM DENISON MINES LIMITED. W. R. Honeywell and W. A. Gow (Canada. Dept. of Mines and Technical Surveys, Mines Branch). Nov. 30, 1964. 24p. (IR-64-102). Dep.(mn).

A flotation pilot plant for the recovery of uranium was operated for 32 days during April and June, 1964, with the object of producing a uranium concentrate suitable for further treatment by leaching. By flotation, the best recoveries obtained ranged from 85 to 94 per cent of the uranium with ratios of concentration of from 2.4 to 2.0:1, respectively. By gravity concentration and flotation, the best recovery obtained was from 85 to 90 per cent of the uranium with ratios of concentration of 3.4 to 2.5:1, respectively. The principal uranium collector used was an emulsion of Acintol FA-1. The total cost of reagents would be in the order of from 21 to 31 cents per ton ore. (auth)

13531 (ORNL-P-902) ANHYDROUS ION-EXCHANGE STUDIES OF ALKALI METAL IONS IN ETHYLENEDIAMINE. D. A. Lee and J. L. Pauley (Oak Ridge National Lab., Tenn.). [nd]. Contract [W-7405-eng-26]. 5p. (CONF-650401-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Chemical Society, Detroit.

Selectivity and diffusion coefficients were measured for alkali metal ions in ethylenediamine ion exchange systems. The exchange was followed with the radiotracers ^{134}Cs and ^{22}Na, and x1, x8, and x16 Dowex 50 resins were used. The Li^+-Cs^+ and Na^+-Cs^+ pairs were found to have rapid diffusion coefficients and larger selectivity coefficients than in water. Other pairs studied included K^+-Cs^+, Cs^+-Cs^+, and Li^+-Na^+. Reasons for the observed differences are discussed. (D.L.C.)

13532 (ORNL-TM-1020) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION C PROGRESS REPORT FOR APRIL 1961–JULY 1961. K. B. Brown (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 47p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Extraction with Dapex synergistic combinations was effective for recovery of U from $(NH_4)_2$ ZrF_6-NH_4F solution resulting from modified-Zirflex dissolution of (cold) Zr–U fuel without nitrate. A tentative chemical flowsheet was devised and tested in batch cascade loading and stripping tests, using water dilution to bring the free NH_4F concentration below 0.5 M, extraction with e.g. 0.1 M D2EHPA–0.05 M TOPO or 0.3 M D2EHPA–0.15 M DAAP,

scrubbing with ~0.2 M fluoride, and stripping with 0.5 M ammonium carbonate. Decontamination of U from Zr–Nb and Ru was improved when their aqueous feeds were treated with HNO_2 and acetone before solvent extraction with phosphates or phosphonates. Further tests with HNO_2 tracer solutions showed the importance of both acetone and HNO_2 in the suppression of Zr–Nb and Ru extraction by TBP. An explanation for these effects might be based on the fact that acetone and certain other ketones react with HNO_2 to form keto-oximes, compounds which are potential complexing agents for metal ions. Diacetylmonoxime, a commercially available keto-oxime, was effective in decreasing the Zr–Nb and Ru extraction by severely degraded TBP-Amsco extracts. The tests explored the dependence of suppression of Zr–Nb extraction on reagent concentration, demonstrated that the reagent has no significant effect on the extraction of U and Th, and showed decontamination advantages in the extraction of Th from both acidic and acid deficient Thorex systems. A keto-di-oxime, in brief testing, also showed suppression of Zr–Nb extraction. Further, the bifunctionality of the keto-oximes was shown to be essential, for analogous reagents with the oxime groups, but without the ketoxy group were ineffective sequestering agents. In extraction of transplutonic elements by tertiary amine chlorides from slightly acidified concentrated LiCl solutions, HCl is also extracted. Tests show that this will not adversely affect the process for separation of the transplutonium and lanthanide groups. Zr and Nb can be extracted from synthetic Purex 1WW solution with several reagents. Di(2-ethylhexyl) phosphoric acid is the most effective and versatile extractant of those tested. The extraction rate, however, is slow and processing would best be carried out as a batch rather than a continuous operation. Other reagents showing ability to extract Zr from Purex 1WW under various conditions include tri-(n-octyl)phosphine oxide (TOPO) and mono-heptadecyl-phosphoric acid (HDPA). Results were favorable in preliminary evaluation of a process for recovering U from organophosphorus esters (TBP, phosphonates) by direct precipitation as ammonium uranyl tricarbonate (AUT). The AUT is readily converted to UO_3 by calcination. In demonstration of the process in mixer-settler equipment with diamyl amylphosphonate extractant, effective U recovery was obtained with low (~0.5 M) HNO_3 salting in the aqueous phase. Phase separation problems, encountered in the stripping system in early tests, were satisfactorily resolved by appropriate modification of the contacting equipment. Effective extraction of U from sulfate solution was given by three new tertiary amines [tri(isodecyl)-, di(n-decyl)-lauryl-, and β-hydroxylauryl-dinonyl-] and by new samples of two tertiary amines previously tested. A procedure was developed for producing semi-porous spheres of BeO in which small (~10 μ) UO_2 particles are contained and enclosed. Essentially the process consists of mixing UO_2 particles in a basic sirupy organic Be salt, dispersing the sirup in an immiscible liquid, and partially drying the dispersed particles with an organic drying agent before agitation is stopped. The resulting beads are then separated, dried further, and the Be compound fired to the oxide. (auth)

13533 (RPI-2714-4) ANODIC DISSOLUTION OF URANIUM. N. D. Greene and L. E. Kindlimann (Rensselaer Polytechnic Inst., Troy, N. Y.). Jan. 1965. Contract AT(30-1)-2714. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The dissolution of uranium was studied by potentiostatic and galvanostatic anodic polarization techniques. Uranium exhibits active-passive behavior in nitric acid, sulfuric acid, and sodium hydroxide. Transpassive dissolution of uranium in acid occurs without gas evolution, giving high current efficiency. At constant potential, transpassive dissolution rate increases with increasing temperature and decreasing acid concentration. These data are discussed in terms of uranium fuel element dissolution processes. (auth)

13534 (WAPD-BT-31(p.69-74)) DETERMINATION OF CESIUM 137 IN THE PRESENCE OF OTHER CESIUM NUCLIDES VIA ITS BARIUM 137m DAUGHTER. D. P. Bour (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

A method for determining cesium-137, which is free of interference from other cesium radionuclides and is based on the isolation and determination of its 2.60-minute daughter barium-137m, is described. The daughter is separated as $BaCO_3$ and decay measurements are made with a high-pressure ionization chamber. The procedure is rapid and yields very accurate results. (auth)

13535 CATION EXCHANGE SEPARATIONS USING AMMONIUM THIOCYANATE–ORGANIC SOLVENT–WATER ELUANTS. Donald J. Pietrzyk and Donald L. Kiser (Iowa State Univ., Iowa City). Anal. Chem., 37: 233-6 (Feb. 1965).

The distribution coefficients of several metals were measured on Dowex 50-X8 with systems containing various ratios of NH_4SCN, organic solvent, and water. The concentration of organic solvent in a system greatly affects the distribution values. The nature of the organic solvent also has some effect. Most metals have decreasing distribution coefficients with increasing amounts of NH_4SCN in methanol. Several separations were performed using eluting agents suggested by the distribution data. (auth)

13536 THE SOLUBILITIES AND ANION-EXCHANGE BEHAVIOR OF RARE EARTH ELEMENTS IN POTASSIUM CARBONATE SOLUTIONS. Tomitsugu Taketatsu (Kyushu Univ., Fukuoka). Anal. Chim. Acta, 32: 40-5(Jan. 1965).

The solubilities of rare earth elements (La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y) in potassium carbonate solution, and the distribution coefficients of the rare earth ions between the carbonate solution and Dowex I resin were measured. The values obtained showed a variation which depended on the concentration of potassium carbonate and atomic number. There was a clearly different tendency in these values between La–Ho and Er–Lu. (auth)

13537 DEVELOPMENT OF PROCESSES FOR NUCLEAR FUEL RECOVERY. PART II. FLUORIDE VOLATILITY PROCESSES. Argonne Natl. Lab. Rev., 2: No. 1, 6-10(Jan. 1965).

The fluoride volatility process for recovery of fissionable and fertile elements from irradiated fuel and blanket material is discussed. The conceptual flowsheet for recovery of uranium from high-enrichment alloy fuels is shown. It employs selective volatilization of chlorides and fluorides. Processing parameters for the recovery of 99% of the uranium from the alloy fuel were established in bench-scale tests. A conceptual flowsheet is also presented for processing fuel composed of Zircaloy-clad uranium dioxide. In this process the fuel material is decladded and then exposed to fluorine to convert the fuel material to volatile UF_6 and PuF_6. An engineering-scale high-alpha facility being constructed to study various steps of the fluoride volatility processes for low-enrichment, plutonium-bearing fuels is described. (M.C.G.)

13538 CHEMICAL REPROCESSING OF U–Al ALLOYS WITH HIGHLY ENRICHED URANIUM. H. Eschnauer and H. Vietzke (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). Atomwirtschaft, 10: 32-5(Jan. 1965). (In German)

In the manufacture of plate-formed uranium-aluminum fuel elements for research and material testing reactors of the swimming-pool or tank types waste containing highly enriched uranium arises at various stages in the fabrication process. It is possible to distinguish essentially two groups of uranium bearing waste according to their kind and impurities. One group is semi-fabricated pieces of U-Al alloys with highly enriched uranium, which do not meet the specification. In the mass production of plate-formed U-Al fuel elements these can, as a rule, be directly re-melted without the expense of reprocessing and can thus be returned to production at no great cost. The second group is crucible residues, casting leftovers, machining chippings and other waste with highly enriched uranium.

These can only be used again after aqueous chemical reprocessing. Because of the high cost of 90% enriched uranium the waste and the scraps must be completely and rapidly reprocessed and fed back into the fuel element production. An important requirement in reprocessing is that there should be minimal final loss. Costs of aqueous chemical processing are low in relation to the value of the uranium and in general should not exceed 10% of this value. The transfer of uranium bearing waste for reprocessing and the clearing of the reprocessed material raise a few difficulties. Because of possible disagreement between the party placing the contract and the processor as to the value and quantity of the scrap metal some guiding principles concerning the reprocessing and the clearance should be agreed between the participating parties, if possible before the transfer of the material. The most important points involved concern the dispatch and receipt control of the waste, particularly careful reprocessing records, as well as the end control of the physical, chemical, and isotopic state of the reprocessed uranium compounds. (auth)

13539 ADSORPTION OF GAS-PHASE IODINE ON DRY ION-EXCHANGE RESINS. A. R. Giona (Universita, Rome). Brit. Chem. Eng., 10: 82-6(Feb. 1965).

The use of strongly basic dry anion exchange resins for recovery and elimination of iodine in gas streams at low concentrations was studied. Experiments on pilot plants established the process mechanism and determined the influence of resin type, temperature, particle size, and chemical form on the adsorption process. The results obtained can be used to develop a process for the removal of radioiodine in the gaseous products arising from the dissolution of nuclear fuels. (auth)

13540 EXTRACTION OF ^{95}Zr IN TRACE CONCENTRATIONS FROM URANYL NITRATE SOLUTIONS EXHIBITING ACID DEFICIENCY BY MEANS OF 30% TRIBUTYL PHOSPHATE. V. Šraier and E. Čakrt (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 29: 2738-52 (Nov. 1964). (In German)

The extractability of zirconium traces from uranyl nitrate solutions was investigated to determine dependence on the aging of hydrolyzed solutions, i.e., on solution exhibiting oxygen deficiencies and on solutions newly acidified. The zirconium re-extraction from organic extractants was investigated in relation to the composition and mass of the wash solution. (tr-auth)

13541 CHROMATOGRAPHIC SEPARATION OF RARE EARTHS BY MEANS OF MACROPOROUS CATION EXCHANGER "KATEX KP-1." J. Alexa (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 29: 2851-5(Nov. 1964). (In German)

By comparison of the kinetic exchange and separation capacities in chromatographic columns of standard polystyrene cations and Czechoslovakian cation exchangers with macroporous structures, the utility of the latter for the complete separation of rare earths was verified. (tr-auth)

13542 ION EXCHANGE ON THE MINERAL CLINOPTILOLITE. Darryl G. Howery and Henry C. Thomas (Univ. of North Carolina, Chapel Hill). J. Phys. Chem., 69: 531-7(Feb. 1965).

Cation-exchange equilibria on the zeolitic mineral clinoptilolite were investigated for the pairs of ions $Na^+ - Cs^+$, $Na^+ - NH_4^+$, and $NH_4^+ - Cs^+$ at 30 and 70°C using column techniques with radioactive tracers. The standard values of ΔF and ΔH are shown to obey the triangle rule with discrepancies of only about 0.1 kcal/mole. The system is discussed in terms of the excess thermodynamic functions. (auth)

13543 SEPARATIONS USING SOLVENT EXTRACTION. H. Green. Metallurgia, 70: 299-300(Dec. 1964).

A survey was made of useful solvent extraction methods for separation of Mo, Ni, Nb, P, Se, Sr, Ta, Te, Th, Sn, Ti, W, U, V, Zn, and Zr ions from solutions. (55 references) (M.C.G.)

13544 SOLVENT EXTRACTION OF XENON. Hiroshi Hamaguchi, Naoki Onuma, Kenji Tomura, and Rokuro Kuroda (Tokyo Univ.). Nature, 205: 279-80(Jan. 16, 1965).

A method is described for the solvent extraction of $^{133, 133m}$Xe and $^{135, 135m}$Xe activities from ^{133}I and ^{135}I nuclides, which were separated and purified from the fission products in an iodide form, using CCl_4. The method enables Xe tracers to be obtained repeatedly from their parent iodine nuclides. Because the CCl_4 extraction system provides a highly specific separation procedure for tracer quantities of Xe, it will apply directly to the separation of short-lived Xe activities from fresh fission products. The method would be of particular value for the decay scheme investigations of short-lived Xe isotopes. (P.C.H.)

13545 THE EUROPEAN INSTITUTE FOR TRANSURANIC ELEMENTS, KARLSRUHE. H. Blank. Neue Tech., 6: 259-65(Oct. 1964). (In German)

The function and installations of the Karlsruhe Institute for Transuranic Elements are described in some detail. (J.S.R.)

13546 APPLICATION OF FOCUSING CHROMATOGRAPHY TO THE SEPARATION OF MILLIGRAM QUANTITIES OF RARE EARTH ELEMENTS. Yuichiro Kamemoto and Kimiko Seki (Japan Atomic Energy Research Inst., Tokyo). Nippon Kagaku Zasshi, 86: 69-73(Jan. 1965). (In Japanese)

Focusing chromatography using thick filter paper was applied to the separation of rare earth elements. The effects of several conditions on the separation were studied. The most satisfactory result was obtained when 0.01N hydrochloric acid was used as the decomplexing agent and 0.1 mol/l citric acid as the complexing agent. The pH gradient of both solutions between anode and cathode was pH 3.3 (HCl) to 4.4 (citric acid). The treatment time was 20 min. After separation, an autoradiographic technique was employed to decide the position of each separated line. By this method, mixtures of several kinds of rare earths (in amounts of mg) could be separated to the radiochemically pure state. (auth)

13547 REPROCESSING RESEARCH AT EUROCHEMIC. R. O. R. Brooks (Medical Research Council, Harwell, Berks, Eng.). Nucl. Eng., 10: 27-30(Jan. 1965).

Research at Eurochemic on dissolution of graphite-carbide fuels, dissolution of zirconium and Zircaloy-clad uranium fuels, reprocessing of highly enriched fuels, and purification of plutonium is summarized. (D.C.W.)

13548 SOLVENT EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION OF URANIUM(VI). Badri V. Agarwal, Satendra P. Sangal, and Arun K. Dey (Univ. of Allahabad, India). Z. Anal. Chem., 207: 256-9 (1965).

Solvent extraction of uranium-sodium diethyldithiocarbamate with ethylmethyl ketone and separation from titanium, zirconium, thorium, lanthanum, and cerium is described. It was found that 11.75 to 47.00 mg of uranium can be extracted from a binary mixture containing 4.78 to 19.04 mg of titanium, 9.12 to 36.48 mg of zirconium, 116.0 to 460.0 mg of thorium, 6.95 to 27.8 mg of lanthanum, or 7.06 to 28.24 mg of cerium at pH 3.0. The pH range between which the separations may be carried out successfully is 2.0 to 3.5. The following cations interfere in the separations: Cu^{II}, Fe^{III}, Co^{II}, Bi^{III}, Ni^{II}, Cr^{VI}, Te^{IV}, Se^{IV}, Ag^{I}, Hg^{II}, As^{III}, Sn^{IV}, Pb^{IV}, Cd^{II}, Mo^{VI}, Mn^{II}, V^{V}, Zn^{II}, In^{III}, Tl^{I}, W^{VI}, Os^{VIII}, and Nb^{V}. (auth)

13549 STUDIES ON THE DISTRIBUTION MECHANISM OF EUROPIUM BETWEEN ALKYLPHOSPHORIC ACID AND AQUEOUS HYDROCHLORIC ACID WITH THE AID OF THE DIFFUSION METHOD. J. Bosholm and W. Pippel (Technische Universität, Dresden). Z. Physik. Chem. (Leipzig), 227: 217-22(1964). (In German)

The distribution of Eu in the di-(2-ethylhexyl)-phosphoric

acid-toluene and water-aqueous hydrochloric acid systems was investigated at various concentrations with the aid of the capillary immersion method. In the > 0.8M alkylphosphoric acid concentration range phase transfer was the rate-determining step. At lower concentrations diffusion of the organic phase was the rate-determining process. The diffusion mechanism is discussed. (OTS)

13550 PUL'SIRUYUSHCHIE EKSTRAKTORY. (Pulsed Extractors). S. M. Karpacheva, E. I. Zakharov, L. S. Raginskii, and V. M. Muratov. Moscow, Atomizdat, 1964. 298p.

The technology of pulsed extractors is discussed and effects of pulsation on the characteristics of the apparatus are analyzed. Various problems in column hydrodynamics and the influence of pulsation on the size and behavior of a drop are discussed. The general concepts and characteristics of extractor efficiency are considered. Descriptions of the design and construction of extractors now in operation and the latest designs of extraction columns are given. Pulsed column construction and calculation methods are described. Various pulse column designs and their performance are discussed. (R.V.J.)

13551 METHOD OF RECOVERING AND ENRICHING URANIUM FROM URANIUM CONTAINING ALLOYS, MIXTURES AND COMPOUNDS BY THERMAL MEANS. Robert J. Teitel (to Dow Chemical Co.). German Patent 1,176,371. Aug. 20, 1964. Priority date Aug. 26, 1958, [United States].

A melt composed of uranium, aluminum, and magnesium was heated and the precipitating intermetallic compounds of uranium and aluminum, especially UAl_2 and/or UAl_3, were separated afterwards. The uranium content of the melt amounted to 1 to 10% with respect to the weight of aluminum. (Gmelin Inst.)

13552 METHOD OF PREPARING A BERYLLIUM SULFATE SOLUTION SUITED FOR RECOVERING BERYLLIUM AND BERYLLIUM COMPOUNDS FROM MINERALS. Victor Rurovschi and Avidiu Popa (to Ministerul Industriei Petrolului si Chiniei). German Patent 1,181,684. Filed July 12, 1961.

The method consists of melting with alkali, taking up the melt with sulfuric acid, separating the precipitated silica, concentrating the filtrate obtained until the first crystals appear at boiling temperature, raising the pH-value to 8.5 to 9 by adding calcium or sodium hydroxide, washing the precipitate obtained at 80 to 90°C with water, dissolving it in sulfuric acid, diluting with water to a density of 1.32, and separating Al in the form of alum by adding ammonium sulfate. (Gmelin Inst.)

13553 PROCESS FOR SEPARATION AND RECOVERY OF VOLATILE FLUORIDE IMPURITIES FROM URANIUM HEXAFLUORIDE CONTAINING THE SAME. W. R. Golliher (to U. S. Atomic Energy Commission). U. S. Patent 3,165,376. Jan. 12, 1965.

A process was developed for separating volatile fluorides of neptunium, technetium, molybdenum, and vanadium from uranium hexafluoride. The UF_6 is contacted with magnesium fluoride, which selectively sorbs the other fluorides. The sorbed fluorides are recovered by washing the magnesium fluoride and contacting the wash solution with an ion-exchange resin. This process was found to be particularly useful for recovering fluorides of technetium and neptunium from UF_6 obtained by reprocessing of irradiated nuclear reactor fuel. (AEC)

13554 SEPARATION OF PLUTONIUM, URANIUM, AND FISSION PRODUCTS FROM EACH OTHER. James B. Knighton and Robert K. Steunenberg (to U. S. Atomic Energy Commission). U. S. Patent 3,169,057. Feb. 9, 1965.

Lanthanides, including yttrium, were separated from actinides in nuclear uranium fuel by contacting the fuel with molten magnesium halide–alkali metal halide or magnesium halide–alkaline earth halide and at the same time with magnesium–zinc or magnesium–cadmium alloy containing at least 18 wt % magnesium. The lanthanides enter the halide, the actinides the alloy. (AEC)

ENGINEERING

General

Refer also to abstract 14202.

13555 (AWRE-E6/64) A MULTI-TON HIGH-EXPLOSIVE AIR BLAST SIMULATOR. Valerie J. Bishop, K. I. Darby, R. Clare, and R. D. Rowe (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Nov. 1964. 38p. Dep.(mn).

The principles of operation of the simulator are explained, followed by a brief general description. Examples of the hydrostatic pressure-time records obtained during the running-up tests are given and compared with those from multi-ton high explosive charges and from British and American nuclear tests. It is concluded that such a simulator can be built for target response and fundamental studies resulting in considerable saving of cost in overseas trial participation. (auth)

13556 (K-D-1780) DESALINATION OF SEA WATER—EVAPORATOR PLANTS. B. E. Mitchell (Oak Ridge Gaseous Diffusion Plant, Tenn.). May 1, 1963. Contract W-7405-eng-26. 56p. Dep.(mn); $3.00(cy), 2(mn) OTS.

An engineering evaluation was made of plants for producing 1 billion gallons of product water per day by the flash evaporation process. Conceptual designs and cost estimates were prepared for three different type plants: modular plant, compact plant, and multilevel plant. (D.L.C.)

13557 (K-D-1845) UF_6 CONTAINER TEST AND DEVELOPMENT PROGRAM AT THE OAK RIDGE GASEOUS DIFFUSION PLANT. Albert J. Mallett (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 7, 1965. Contract W-7405-eng-26. 34p. (CONF-650103-5). Dep.(mn); $2.00(cy), 1(mn) OTS.

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

Tests were made on several cylinder containers for shipment of UF_6 and other uranium materials. The tests included burst strength, package drop, container drop, fire, and tie-down tests. The results of the tests are shown in photographs. (D.L.C.)

13558 (LADC-6267) ON BRISANCE, AND A PLATE-DENTING TEST FOR THE ESTIMATION OF DETONATION PRESSURE. Louis C. Smith (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A plate-denting test is proposed as a simple, quantitative measure of the brisance of an explosive. The results of the test correlate reasonably well with the available experimental data on detonation (Chapman-Jouguet) pressure, and it is concluded that the detonation pressures of most high explosives of military interest may be estimated with reasonable confidence from the more easily measured plate-denting values. It is also shown that equally useful estimates of detonation pressures may be obtained from experimentally measured detonation velocities by means of the equation $P = 0.2582\ \rho_0 D^2$. For the explosives considered, with the exception of one lead-loaded composition, the average absolute difference between the estimated and measured pressures is 12 kbar for the $\rho_0 D^2$ estimate and 14 kbar for the plate-dent estimate. The plate-denting value of the lead-loaded explosive, which contained over 70 weight percent of lead, is more than twice what it would be predicted to be on the basis of its experimentally measured detonation pressure. (auth)

13559 (RISLEY-Trans-280) EFFECT OF THE TIME FACTOR ON THE STRENGTH OF A SPHERICAL SHELL SUBJECTED TO INTERNAL PRESSURE. M. I. Rozovskii. Translated from Izv. Akad. Nauk SSSR, Otd. Tedhn. Nauk, Mekhan. i Mashinostro., No. 4, 124-9 (1961). 9p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mf) JCL.

The case of a thin spherical shell of a very ductile material with relaxation properties is analyzed. The maximum (critical) pressure which the shell can withstand is determined as a function of time, along with the critical strain. An example is considered in which a shell made out of synthetic rubber is used. (D.L.C.)

13560 INTRODUCTION TO CRYOGENIC ENGINEERING. David D. Reiff (Atomic Energy Commission, Washington, D. C.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/PID-8, 12p. $1.00. (CONF-763-15)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

A few of the essential disciplines in cryogenic engineering are introduced. The basic principles of liquefaction of gases and low-temperature heat transfer and insulation are briefly treated. The discussion of storage, transfer, and handling of cryogenic fluids has been slanted to hydrogen; however, the basic principles of cryogenic technology are embraced. In addition, mobile ground-service equipment is discussed briefly. (auth)

Applications of Nuclear Explosions

13561 (AD-439079) MODEL STUDIES OF EXPLOSION-GENERATED SEISMIC WAVES. Semi-annual Technical Report No. 3, October 1, 1963–March 31, 1964. Carl Kisslinger (Saint Louis Univ.). Contract AF19(628)-1689. 23p.

The principal effort was directed to the study of P and S wave radiation patterns from explosions in rectangular cavities. Both aluminum and Plexiglas were used for the purpose. The results and conclusions reached are discussed. Decoupling experiments were started in aluminum, Plexiglas, and Styrofoam. The preliminary results indicate several interesting features which are not completely understood. Additional data will be obtained in an effort to clarify the significance of the results. (N.W.R.)

13562 USEFUL NUCLEAR EXPLOSIVES. Gerald W. Johnson and Gary H. Higgins. Intern. Sci. Technol., No. 38: 54-60(Feb. 1965).

The economics and technology of the use of nuclear explosives for excavation, mining, isotope production and power generation are discussed with particular consideration of the Plowshare program and its implications for the construction of a sea-level canal across the American isthmus. (D.C.W.)

13563 ON USING THE HEAT GENERATED IN A NUCLEAR EXPLOSION FOR INTENSIFICATION OF PETROLEUM EXTRACTION. L. G. Filippenko and A. N. Shcherban (Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 10, 1311-13(1964). (In Ukrainian)

The temperature distribution in soil was calculated after a short and long time following a nuclear explosion. It is shown that the heat of the explosion can be utilized for petroleum extraction. The maximum value of the average temperature in the soil was found to depend on the mechanical properties of the soil only, and not on the charge of explosive. (auth)

13564 A TRACER TECHNIQUE FOR CRATERING STUDIES. C. H. H. Diehl and G. H. S. Jones (Suffield Experimental Station, Ralston, Alberta, Can.). J. Geophys. Res., 70: 305-9(Jan. 15, 1965).

A method is outlined whereby marker cans are used in colored sand columns to measure the ejecta and ground movements in the vicinity of a crater from a 20-ton surface burst TNT detonation. It is shown that the use of marker cans greatly increases the data obtained from the sand columns, with comparatively little increase in the cost of the operation. Also, data are obtained in the form of displacement vectors which may be compared with the velocity vector field predicted by hydrodynamic theory. (auth)

13565 EVALUATION OF NUCLEAR EXPLOSIVES IN MINING AN ORE BODY BY UNDERGROUND METHODS. W. E. Jones (Climax Molybdenum Co., New York). 12p. (CONF-718-5)

From American Institute of Chemical Engineers Meeting, Las Vegas, Nev., Sept. 1964.

The potential application of nuclear explosives to mine a low-grade molybdenite ore body is considered in detail. The geology of the ore body is described, and the limitations on the use of nuclear explosives in this case are outlined. In this application, 7 nuclear devices of total yield 78 kt would be detonated simultaneously near the bottom of the ore body, and no venting into the atmosphere would occur. For economic comparison, preliminary plans using conventional caving methods were also developed. The disadvantages of lack of data on the simultaneous explosion of an array of nuclear devices and of delayed production ruled out this application of nuclear explosives. (D.L.C.)

Facilities and Equipment

Refer also to abstracts 12899, 13241, 14169, and 14882.

13566 (AD-421061) SUPPORTING TESTS FOR A SUPERCONDUCTING, ROTATING, ELECTRIC GENERATOR. Report No. 428. Second Quarterly Progress Report. E. H. Sibley, E. F. Doyle, and C. J. Oberhauser (Dynatech Corp., Cambridge, Mass.). Oct. 1963. Contract AF33 (657)-11062. 22p. $2.60(OTS).

The feasibility of the application of superconductor technology to the generation of electrical power by rotating electromagnetic devices is studied. Since the anticipated use of such a generator is for long missions, a refrigerator with associated equipment must be considered part of the package. The work includes analytical and design studies of both electrical and mechanical components. (auth)

13567 (BNL-7804) A DESICCANT-HOLDING SLIDE BOX FOR RADIOAUTOGRAPHIC EXPOSURE. Julius M. Elias (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A double-depth plastic slide box is made by removing the bottoms of two standard 25-slide boxes and cementing the remaining frames together, bottom to bottom. A desiccant is placed in one box cover and fitted to the lower section of the cemented unit. A piece of screening is placed over the desiccant, the upper section filled with slides for radioautography, and the empty cover applied to the top of the assembled box. Thus all slides are kept effectively and uniformly dehydrated during exposure. (auth)

13568 (HW-76160) A TAPE PUNCH READOUT FOR THE 333 BUILDING FUEL ELEMENT MEASUREMENT FACILITY. G. E. Driver (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 2, 1963. Contract AT(45-1)-1350. 31p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

The dimensional variations in cylindrical fuel elements for reactors are analyzed by recording the displacement of a probe normal to the surface as the cylindrical element is rotated in a circle about its axis. Equipment is described whose purpose is to convert automatically the analog probe displacement into digital form on a medium convenient for input into a digital computer. The equipment is suitable for analyses on any process in which the variable to be recorded is represented by a shaft rotation. (T.F.H.)

13569 (KLX-1866) PRELIMINARY DESIGN REPORT, TITLE I ON MOBILE GAMMA IRRADIATOR. (Vitro Engineering Co., New York). Oct. 30, 1964. Contract AT(30-1)-3389. 98p. Dep.; $3.00(cy), 2(mn) OTS.

The Mobile Gamma Irradiator is a semi-production demonstration unit for irradiating fruit and farm produce with pasteurization doses. The irradiator, including tractor, trailer, and all equipment, weighs 56-59 tons and can be transported over public roads with overload permits; rail transportation was also investigated. A source cask was designed for the shipping and storage of the cobalt source. Ventilation and refrigeration systems are provided. (D.L.C.)

13570 (SAN-8002(p.258-64)) SODIUM PUMP DEVELOPMENT STUDY. J. H. Wright (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh).

A discussion is presented of the problem areas in development of sodium pumps for reactors in the range of 1000 to 1500 Mw(e). Several concepts for such pumps are discussed. (T.F.H.)

13571 (TID-21359) PRELIMINARY DESIGN REPORT FOR MARINE PRODUCTS DEVELOPMENT IRRADIATOR FACILITY. (Associated Nucleonics, Inc., Garden City, N. Y.). Mar. 15, 1963. Contract AT(30-1)-3181. (AN-144). 150p. Dep.; $4.00(OTS).

The facility is to be used for research and development on the preservation of marine products by gamma irradiation using a ^{60}Co source. Products to be irradiated are delivered in packages ready for irradiation, and refrigeration storage for product before and after irradiation is provided. Preliminary design, design criteria, outline specifications, cost estimate, and project schedule are presented. (D.L.C.)

13572 METALLOGRAPHIC CELL FOR INVESTIGATIONS ON IRRADIATED FUEL ELEMENTS. H.-L. Krautwedel (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 7: 26-9(Jan. 1965). (In German)

A gastight, lead-shielded cell for investigations on fuel elements and structural materials was described, which contains equipment for metallographic work, hardness measurements, density measurements, electrical conductivity measurements, and gage control. Details are given on the built-in instruments, and the necessary operations for the reconstruction of these instruments for remote handling are stated. Finally, a description on the procedures used for preparing metallographic samples of metallic uranium is made. (auth)

13573 BALL BEARING PERFORMANCE IN HELIUM ATMOSPHERE AT 500 DEG F. Jamshed B. Havewala and John H. Johnson (Marlin-Rockwell Corp., Jamestown, N. Y.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/LUB-8, 12p, $1.00. (CONF-763-24)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The results of a program to develop bearings to operate in gas-cooled nuclear reactor mechanisms in a helium atmosphere at 510°F are presented. Testing was conducted to compare the performance of several dry-film lubricants applied to the cages of deep-grooved ball bearings operating under combined thrust and radial loads. The investigation revealed the importance of bearing internal clearance, cage clearance, and dry-film application procedures, to successful operation. A 25-mm bore bearing incorporating a cage coated with sodium silicate bonded, molybdenum disulfide-graphite dry film, operated for nearly 2,000,000 revolutions at 300,000 psi maximum Hertz stress with only 0.00075 in. axial wear and 0.0002 in. change in radial clearance. The effect of speed on dry-film-lubricated bearing performance was also investigated. A comparison was made between dry film lubricated bearings and unlubricated, full-complement

type bearings for slow-speed operation. Unlubricated bearings performed unsatisfactorily. Four test runs of 500-hr duration were completed satisfactorily with 150 mm bore bearings, dry-film lubricated, operating under combined thrust and radial load at 1.5 rpm. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 13883 and 14795.

13574 (AECL-2109) TWO METHODS OF IMPROVING THE DRYOUT HEAT FLUX FOR HIGH-PRESSURE STEAM/WATER FLOW. E. O. Moeck, G. A. Wikhammer, I. P. L. Macdonald, and J. G. Collier (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1964. 28p. $1.50 (AECL).

Dryout heat flux data for high-quality steam–water flow at 1000 psig were obtained in a uniformly heated tube with and without twisted ribbon swirl promoters. The twisted ribbons increased the dryout heat flux provided that the steam quality at the outlet was less than 90% and the mass velocity greater than 0.5×10^6 lbm/ft^2-hr. Experiments were also done with an internally heated annulus having roughness rings of various heights and spacings on the unheated wall. In all cases, the roughened annuli sustained heat fluxes superior to those of a smooth annulus. The results support the liquid film flow hypothesis framed during previous experiments. (auth)

13575 (ANL-6958) DEVELOPMENT OF A FLUOROSCOPE FOR STUDYING TWO-PHASE FLOW PATTERNS. John Johanns (Argonne National Lab., Ill. and [International] Inst. of Nuclear Science and Engineering, Argonne, Ill.). Oct. 1964. Contract W-31-109-eng-38. 40p. Dep.; $2.00 (cy), 1(mn) CFSTI

Thesis submitted to Technische Hogeschool, Delft, Netherlands.

A study was made of the feasibility of using an x-ray fluoroscopic system to observe two-phase flow patterns in high-pressure systems. The principles of the method and the components are described, and results are given of air–water and steam–water tests. It is concluded that the fluoroscope can discern between bubble, slug, churn, and annular flows if the liquid flow rate is below a certain limit. Recommendations are given for improving the fluoroscope. (D.L.C.)

13576 (ANL-6980) A STUDY OF THE INITIATION OF NUCLEATE BOILING IN THE LIQUID METALS. Robert E. Holtz (Argonne National Lab., Ill.). Dec. 1964. Contract W-31-109-eng-38. 22p. Dep.; $2.00(OTS).

An analysis was conducted to predict the liquid superheats that will be required to initiate nucleate boiling in the alkali metals. The classical two-phase mechanical and thermal equilibrium equation is solved by applying a modeling of the behavior of the pressure in the liquid for water and the alkali metals. Curves are presented showing the liquid superheats required for nucleate boiling in sodium and potassium. (auth)

13577 (BAW-1280-21) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 19, November 1964. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 67p. Dep.(mn); $3.00 (cy), 2(mn) OTS.

Background information on the various phases of the work is presented, and the present status of each phase is summarized. The preliminary design of the full-size steam generator is complete. The preliminary design of the prototype steam generator is approximately 50% complete. The analysis of sodium–water reaction problems in full-size and prototype steam generators is reported. (auth)

13578 (BNL-7664-R) HEAT TRANSFER TO LIQUID METALS FLOWING PAST SPHERES AND ELLIPTICAL-ROD BUNDLES. Chia-jung Hsu (Brookhaven National Lab., Upton, N. Y.). Feb. 1964. Contract AT(30-2)-Gen-16. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Theoretical Nusselt numbers were derived for the cases of heat transfer to liquid metals flowing past a single sphere, and past an elliptical rod (solitary or one inside a bundle of elliptical rods). The analyses are based on the usual assumptions associated with inviscid potential flow. The normalized hydrodynamic potential drop, $\phi_1/(a + b)$, which appears in the expression for the Nusselt number for elliptical-rod bundles, was analytically evaluated using the mathematical function of Howland and McMullen and by applying the principles of conformal transformation. It was found that the numerical values of the corresponding parameter, ϕ_1/D, for flow through circular-rod bundles were applicable here, provided that certain changes in notation were made. (auth)

13579 (BNL-7851) A CAUCHY PROBLEM FOR THE HEAT EQUATION. J. R. Cannon (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A Cauchy problem is considered for the simple case of the heat equation, and for bounded solutions an explicit estimate of the solution is derived in terms of the bound on the Cauchy data and the bound on the solutions. (C.E.S.)

13580 (NP-14557) BESCHREIBUNG DES INSTABILITATENVERSUCHSSTANDES DER AEG-KERNENERGIEVERSUCHSANLAGE IN GROSSWELZHEIM. (Description of the Instability Test Facility of the AEG Nuclear Energy Research Installation in Grosswelzheim). (Allgemeine Elektrizitätsgesellschaft, Frankfurt am Main). Feb. 25, 1963. 22p. Dep.(mn).

The test station constructed to study reactor instabilities in a boiling water reactor consists of a heating channel, pressure vessel, recoil tube, mixing chamber, forced circulation pump, condenser, and supercooler. These correspond respectively to the reactor coolant channels, reactor container, back flow space, and the mixing area in the reactor pressure vessel under the core. Each of these is described. The control and instrumentation of the test station are also discussed. (J.S.R.)

13581 (SAN-8002(p.176-88)) SCTI STEAM GENERATOR FABRICATION. P. S. Otten (Baldwin-Lima-Hamilton Corp., Philadelphia).

The design features and fabrication of the steam generator for use in the Sodium Components Test Installation are discussed. (T.F.H.)

13582 (SAN-8002(p.231-57)) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. P. B. Probert (Babcock and Wilcox Co., [Lynchburg, Va.]).

The design of a 1000-Mw(t) Na-heated steam generator comprising three 333 Mw(t) loops in parallel is described. The development of materials for the generator is outlined. The design of a prototype is discussed. The heat transfer properties of helical tubes, which are used in the generator, are investigated. An experimental investigation of the corrosion of Croloy 2¼ steel by the products of the Na-H_2O reaction is presented. (T.F.H.)

13583 (WCAP-2056(Pt.V)) HIGH TEMPERATURE SUPERCRITICAL PRESSURE WATER LOOP. PART V. FORCED CONVECTION HEAT TRANSFER TO WATER AFTER THE CRITICAL HEAT FLUX AT HIGH SUBCRITICAL PRESSURES. A. A. Bishop, R. O. Sandberg, and L. S. Tong (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Dec. 1964. Contract AT(30-1)-2948. 66p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Data were obtained for forced convection heat transfer to water at high subcritical pressures during once-through operation, with particular emphasis on the high steam quality region after the critical heat flux. Heat transfer coefficients were determined for flow inside circular tubes for two test sections. Pressures ranged from 2420 to 3120 psia, mass flow rates from 0.5 to 2.5×10^6 lb/hr-ft^2, heat fluxes from 0.1 to 0.65×10^6 Btu/hr-ft^2, and qualities from 10 to 100%. As a result of the above study, the following

correlation was obtained for computing heat transfer coefficients after the critical heat flux in the high quality region for mass flow rates equal to or greater than 1.0×10^6 lb/hr-ft^2: $(hD/k)_w = 0.098\ (DV_b\rho_w/\mu w)^{0.80}\ (N_{Pr})_w^{0.83}\ (\rho_g/\rho_l)^{0.50}$ ($2\sigma = 17\%$). The data were also correlated to include the effect of the length from the beginning of nucleate boiling. A strong effect was found at small L/D as evidenced by the following correlation: $(hD/K)_w = 0.555\ (DV_b\rho_w/\mu w)^{0.82}\ (N_{Pr})_w^{0.96}\ (\rho_g/\rho_l)^{0.34}\ [1 + (26.9/L/D)]$ ($2\sigma = 14.5\%$). The correlation without the length effect compared favorably with existing data for cylindrical tubes over a pressure range of 1400 to 3100 psia. (auth)

13584 (WCAP-3736(Vol.I)) DNB (BURNOUT) STUDIES IN AN OPEN LATTICE CORE. VOLUME I. L. S. Tong, H. B. Currin, and F. C. Engel (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Aug. 1964. Contract AT(30-1)-3064. 94p. Dep.(mn); $3.00(cy), 2(mn) OTS.

An extensive study of DNB (Departure from Nucleate Boiling) in an open lattice core has been performed. The existing experimental DNB data were reviewed and compiled. Using the resulting library, the accuracy and applicability of certain existing correlations have been checked. The effects on DNB of the independent parameters of a system have been studied and the results have been summarized. Ten foot long, five-rod bundle, electrically heated DNB test sections with a non-uniform axial heat flux were designed and tested. The results are presented and discussed. Pool boiling DNB heat fluxes have been obtained for a boric acid solution at atmospheric pressure. No significant difference between these fluxes and those obtained for pure water was found. Two engineering DNB correlations for application to a rod bundle design have been developed. A modification of these correlations to predict DNB in an annular channel was obtained. (auth)

13585 (WCAP-3736(Vol.II)) DNB (BURNOUT) STUDIES IN AN OPEN LATTICE CORE. VOLUME II. L. S. Tong, H. B. Currin, and F. C. Engel (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Aug. 1964. Contract AT(30-1)-3064. 317p. Dep.(mn); $7.00(cy), 10(mn) OTS.

A tabulation is presented of experimental DNB (Departure from Nucleate Boiling) data, which have been used in developing DNB correlations for water flow through open rod-lattice cores. (T.F.H.)

13586 (WAPD-Trans-15) RESULTS OF AN INVESTIGATION OF THE SPEED OF SOUND IN MOVING GAS-LIQUID MIXTURES. N. I. Semenov and S. I. Kosterin. Translated for Westinghouse Electric Corp., West Mifflin, Penna., from Teploenerg., 11: No. 6, 46-51(1964). 13p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

The theory of transmission of sound waves in two-phase gas–liquid flows in tubes is evolved, and the results are compared with experimental results obtained on steam–water systems. (T.F.H.)

13587 THEORY OF NUCLEATE POOL BOILING. J. Madejski (Politechnika Gadanska, Gadansk, Poland). Intern. J. Heat Mass Transfer, 8: 155-71(Jan. 1965).

Heat transfer under conditions of nucleate pool boiling in a superheated liquid on a horizontally submerged flat plate was studied. Integration of the heat flux equation is presented. The first crisis of boiling is discussed. Experimental data for water are compared. The influence of the heated surface is considered. A mechanism for nucleate boiling is postulated. (M.C.G.)

13588 ALLOWABLE RATES OF HEAT-TRANSFER FLUID TEMPERATURE CHANGE. A. S. Trofimov (Inst. of Physics and Power Engineering, Obninsk, USSR). Inzh-Fiz. Zh., No. 11, 28-31(Nov. 1964). (In Russian)

Analytical expressions for the determination of allowable rates of heat-transfer fluid temperature change in a transient region at the outlet of the atomic reactor core are presented. The value of these rates is limited by thermal stresses arising due to a thermal shock in the first contour of the unit. For the derivation of the formulas, the predicted data of Fritz were used. The Langer curve which is obtained from the treatment of experimental data on thermal fatigue is recommended as allowable elastic stresses. (auth)

13589 FLOW FRICTION OF A STAGGERED TUBE BUNDLE IN A LONGITUDINAL AIR FLOW. A. I. Mikhailov, E. K. Kalinin, and G. A. Dreitser (Aviation Inst., Moscow). Inzh.-Fiz. Zh., No. 11, 42-6(Nov. 1964). (In Russian)

Experimental results are presented on the flow friction of a staggered tube bundle with s/d = 1.2 in a longitudinal air flow within the range of Reynolds number from 10^3 to 10^5 in the range of a temperature factor from 0.88 to 1.25, the effect of isothermal flow on the flow friction was investigated. In heating this effect is essential and accounted for by correction factors. In cooling it is negligible. A generalized formula is proposed which accounts for the effect of s/d on the flow friction of staggered tube bundles. (auth)

13590 EXPERIMENTAL STUDIES ON Al-FOIL THERMAL INSULATIONS FOR NUCLEAR REACTOR VESSELS. Ishikawajima-Harima Eng. Rev., 4: 549-55(Nov. 1964). (In Japanese)

The thermal characteristics of Al foil insulation were investigated, including gross thermal conductivity and surface heat transfer rate and coefficient. The effects of several parameters were considered. The results showed that Al insulation could minimize heat flow with a suitable choice of air space width. The results also showed that gross thermal conductivity would be less than 0.1 kcal/h.m.°C and that the over-all heat transfer rate could be limited to within 200 kcal/h.m^2. (D.C.W.)

13591 CYLINDRICAL SHELL FLUTTER IN HIGH-TEMPERATURE FIELD. S. A. Ambartsumyan and G. E. Bagdasaryan. Izv. Akad. Nauk SSSR, Mekhan. i Mashinostr., No. 5, 77-82(Sept.-Oct. 1964). (In Russian)

Formulas were developed for supersonic stream lined gas flow along an infinite cylindrical shell at a steady velocity. The calculations were based on the Kirchoff-Love hypothesis for nondeformable normals, the Neumann hypothesis on the absence of shifts due to temperature variations in an infinitely small element of shell, the principle of two-dimensional profiles in determining the aerodynamic pressures, and simplifications for the theory of shells with large index variability. (R.V.J.)

13592 HYDROMAGNETIC STABILITY OF DISSIPATIVE VORTEX FLOW. Tien Sun Chang and Walter K. Sartory (Oak Ridge National Lab., Tenn.). Phys. Fluids, 8: 235-41 (ORNL-P-73)

An analysis which considers the stability of dissipative, conducting, incompressible, pure vortex flow (vortex flow with 1/r-transverse velocity profile) in an axially applied magnetic field is presented. The vortex is assumed to be confined within two nonpermeable, rotating, perfectly conducting, cylindrical walls. The results of the analysis confirm the exact criteria reported previously for the limiting cases of inviscid flow with finite or infinite electrical conductivity. The paradox between the inviscid hydromagnetic results and Rayleigh's criterion for inviscid, incompressible, pure vortex flow without magnetic interaction is resolved. (auth)

13593 SUBCOOLED SWIRL-FLOW BOILING AND BURNOUT WITH ELECTRICALLY HEATED TWISTED TAPES AND ZERO WALL FLUX. W. R. Gambill (Oak Ridge National Lab., Tenn.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-42, 8p, $1.00. (CONF-763-22).

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

A series of swirl-flow tests was conducted in which all of the heat was generated in twisted-tape swirl generators. Water from a constant-head tank flowed by gravity at 5 to 8 fps through a vertical 0.27-in.-ID glass tube ~13 in. long, in which was located a resistance-heated, 16-mil-thick A-nickel tape. Tape twist ratios were varied from 2.7 to ∞ inside tube diameters/180° twist, inlet water temperatures from 63 to 173°F, and heat fluxes from 0.21×10^6 to $1.20 \times$

10^6 Btu/hr.ft^2. The water head above the top of the tube was held at 30.7 in. In all cases, the critical wall superheat increased with decrease of tape twist ratio, whereas the critical heat fluxes for the twisted tapes fell between 93 and 122% of those for flat tapes, maximizing in all cases at a tape-twist ratio of 7 to 10. It is postulated that the deterious effect of centripetal acceleration with this geometry, which tends to hold the vapor on the heated surface, is compensated in the swirl-flow entrance region by inertial impingement of the liquid onto the tape surface, and along the remainder of the length by a double-vortex secondary flow pattern in the plane normal to the tube wall. The power density of a swirl-flow tube assembly may therefore be significantly increased by generating heat in the twisted tape as well as in the tube wall. (auth)

13594 FORCED-FLOW TRANSITION BOILING EXPERIMENTS IN A TWO-ROD TEST SECTION AT HIGH PRESSURES. John E. Hench (General Electric Co., San Jose, Calif.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-44, 16p, $1.00 (CONF-763-25).

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

A study was undertaken to determine the feasibility of operation beyond the critical heat flux and to determine the severity of conditions when operating near or beyond the critical heat-flux conditions in a flowing system. Experimental data were obtained beyond the critical heat flux in the transition and film-boiling regime of forced-convection heat transfer to water at 600, 1000, and 1400 psia. The range of steam quality at the two-rod test-section exit was from 20 to 100%; the mass velocities were 0.5, 1.0, 1.4, and 1.95 Mlb/hr-ft^2. The data obtained indicate that for appropriate values of mass velocity and steam quality, operation beyond the critical heat flux in forced-convection heat transfer is possible using standard commercially available materials. (auth)

13595 HEAT-DRIVEN PRESSURE AND FLOW TRANSIENTS IN THE SUPERCRITICAL THERMODYNAMIC REGION. Bill J. Walker and Darrel G. Harden (Univ. of Oklahoma, Norman). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-37, 5p, $1.00. (CONF-763-27)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The results of an experiment to produce fluctuations in the supercritical thermodynamic portion of the single-phase supercritical-pressure region characterized by a maximum in the density-enthalpy product, using four different fluids; namely, water, Freon-114, Freon-12, and carbon dioxide, are presented. A closed natural circulation loop instrumented for pressure and flow measurements was used. (P.C.H.)

13596 NATURAL CONVECTION INSIDE A CIRCULAR CAVITY. P. T. Chu (Shell Pipe Line Corp., Houston, Tex.) and F. G. Hammitt. New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/HT-51, 15p, $1.00. (CONF-763-29)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

An analysis was carried out to determine the heat-transfer rate and laminar fluid motion of natural convection inside a circular cavity. The boundary layer solutions are applicable to fluids of arbitrary Prandtl number. Experiments in water and mercury were conducted to supplement the theoretical analysis. Data from water tests verified the validity of the theory while data from mercury tests show considerable discrepancy from the prediction. This disagreement is believed to be due to the local turbulent mixing that restrains the fluid motion, giving rise to a Nusselt number much smaller than that predicted. (auth)

13597 THEORETICAL EFFECTS OF SPACE AND NUCLEAR HEATING ON TEMPERATURE RISE OF HYDROGEN PROPELLANT IN A NUCLEAR SPACE VEHICLE. J. J. Brogan and Raphael J. Jaffe (Lockheed Missiles and Space Co., Sunnyvale, Calif.), 1964, Preprint No. 64-WA/HT-18, 9p, $1.00. (CONF-763-28)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Liquid-hydrogen impulse propellant on a nuclear stage was exposed simultaneously to space and nuclear heating. Each heating source entered the propellant in a different manner and each affected fluid-dynamic behavior differently. It is shown that the behavior of the liquid when heated influences the temperature rise. Turbulent mixing of the bulk propellant and stratification of propellant entrapped in a turbulent, free-convection boundary-layer flow along propellant tank walls were two flow phenomena expected in the hydrogen propellant on the nuclear stage. Theoretical predictions are made of the propellant temperature rise owing to space heating, to nuclear heating, and then to this combined-heating environment. It is shown that superposition of each heating source on temperature rise does not define temperature rise in a combined environment. (auth)

13598 MEASURED TEMPERATURE PROFILES WITHIN THE SUPERHEATED BOUNDARY LAYER ABOVE A HORIZONTAL SURFACE IN SATURATED NUCLEATE POOL BOILING OF WATER. B. D. Marcus (Technische Hogeschool, Delft, Netherlands) and D. Dropkin. New York, American Society of Mechanical Engineers, 1964, Paper No. 64-WA/HT-4, 8p. $1.00. (CONF-763-13)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

Temperature measurements were made within the superheated boundary layer above and adjacent to a horizontal heating surface in saturated, nucleate, pool boiling of water. A microthermocouple probe was used to measure the average temperature profiles and the temperature fluctuations within the boundary layer at heat fluxes from 1000 to 40,000 Btu/hr ft^2. Correlations are presented for the extrapolated thickness of the boundary layer (δ) as well as the temperature distribution within it. It was found that the δ could be expressed in terms of the heat-transfer coefficient by $\delta = Ch^d$. The behavior of δ with system parameters was found to agree with that predicted by Han and Griffith and Hsu in their theories of nucleation from surface cavities. The temperature distribution in the boundary layer from the surface to 0.57δ was essentially linear and could be expressed $(T-T_b)/(T_s-T_b) = 1-(y/\delta)$. Above 0.57δ the temperature profile became an inverse power function of the height above the surface: $(T-T_b)/(T_s-T_b) = D(y/\delta)^{-a}$. (auth)

Materials Testing

Refer also to abstracts 13702, 13916, and 14765.

13599 (SAN-8002(p.151-75)) SODIUM COMPONENTS TEST INSTALLATION. R. Cygan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

Construction of the SCTI is now 80% complete. All work external to the steam generator pit will be completed at the time the steam generator arrives. All the preliminary construction required for installation of the ALCO unit will be completed before the unit arrives at the site. The only work to be completed after the unit arrives is the tie of piping to the unit, hookup of instrumentation, and application of thermal insulation. The safety aspects have been analyzed and the system as designed does not present any abnormal hazard. (auth)

13600 (AWRE-Trans-49) NEW IMPACT TESTING MACHINES FOR HIGH-SPEED MECHANICAL TESTING OF MATERIALS. V. G. Kononenko, S. G. Kushnarenko, V. I. Kotel'nikov, D. A. Raizman, and I. A. Checheta. Translated by M. F. Christophers (U.K.A.E.A. Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.), from Kuznechno-Shtampovochnoe Proizv., No. 5, 27-31(1963). 16p. Dep.(mn); $1.00(cy) 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

Two explosive impact machines are described for

carrying out tests on materials at high rates of deformation over a wide temperature range. The telescopic machine can be used at −196 to 1200°C and deformation rates of 15-300 m/sec, while the lever-type machine can be used only at rates of 10-50 m/sec. The operation of the machine is described, and the recording of the stress curves with an oscilloscope is discussed. (D.L.C.)

13601 DRY RADIATIVE PHOTOGRAPHY. S. Nadami. Genshiryoku Kogyo, 10: No. 2, 22-6(1964). (In Japanese)

In dry radiation photography, a light-sensitive layer of selenium is deposited, in a vacuum, on a smooth base. The Se is charged with cations by a corona discharge in a dark chamber. When x rays fall on the layer through the photographed object, a potential is created, its magnitude depending on the x-ray intensity. Negatively charged resin powder develops the image, which is made permanent by dissolving the organic material or heating the resin. Weakening of the charge by x radiation depends on the layer characteristics, e.g., thickness and the type and amount of x ray. Equations showing the dependency are given. The process is rapid, cheap, and easy to carry out, and the image produced is clear. (IIC-M.G.)

13602 DEFECTOSCOPY IN NUCLEAR INDUSTRY. T. Aoki. Genshiryoku Kogyo, 10: No. 2, 27-31(1964). (In Japanese)

Typical industrial defectoscopy devices are described. Ultrasonic defectoscopes currently in use are of the impulse-reflection, impulse penetration, continuous penetration, and resonance types. The sound frequency is from 400 kc/sec to 25 Mc/sec. In continuous automatic examination of uranium with frequencies of 1-5 Mc/sec, 2-mm-dia defects were found at 70 mm depth and 0.3-mm-dia defects in 25-mm-dia rods. With resonance defectoscopes, crystalline granules were found, and with reflection and penetration types anisotropic crystalline granularity was studied and heat conduction was measured in cladding material. The microstructure and nonhomogeneous composition of conductors were verified by eddy currents. With a small pipe 1 meter long and an eddy current of 10 cm/sec velocity, 400 samples can be examined in 8 hr for defects at 0.06 mm depth. With beryllium and magnesium alloys, i.e., elements with low atomic numbers, soft x rays may be used, but with uranium, high-energy x and gamma rays must be used. (tr-auth)

13603 NEUTRON RADIOGRAPHY AS AN INSPECTION TECHNIQUE. H. Berger. 5p. (CONF-630905-1)

From 4th International Conference on Non-Destructive Testing, London.

The difference in absorption characteristics between neutrons and x rays is pointed out. Some of the techniques used for neutron radiographic inspection are discussed briefly: neutron sources, image detectors, and photographic detection methods. The use and problems of neutrons in the inspection of large thicknesses of heavy metals are discussed. Other applications of neutron radiography are also considered, e.g., in inspection of irradiated fuel elements. (D.L.C.)

13604 PORTABLE RADIOGRAPHIC EXPOSURE UNIT. Caleb P. Moore (to General Motors Corp.). U. S. Patent 3,161,776. Dec. 15, 1964. Filed Mar. 20, 1961.

The portable radiographic exposure unit patented is lightweight, compact, and serves as a storage container for a low-energy cermet-type gamma source using either a rare earth metal or a rare earth oxide powder mixed with Al. A shutter or slide member in the unit is designed in such a manner that the source may be completely encased in shielding material during transportation and/or storage or may be positioned over a very thin stainless steel diaphragm that opens into a conical aperture to the bottom of the unit when the unit is in use. The design of the unit can be extended to provide for the use of two or more sources so that the operator can selectively expose the desired source. (A.G.W.)

Protective Structures

Refer also to abstract 13698.

13605 (AD-605502) AIR-FILTER SHIELDING FOR EMERGENCY SHELTERS. N. Oldson, C. A. Dittus, and W. R. Nehlsen (Naval Civil Engineering Lab., Port Hueneme, Calif.). Aug. 19, 1964. 12p. (R-326). $0.50(OTS).

Experiments were conducted to show which particle sizes of fallout falling from altitudes of 10,000 feet or more would be drawn into a typically protected shelter air intake. Results indicated that practically no particles over 60 microns in diameter would be captured. Some particles in the 30- to 60-micron-diameter size range were captured, and almost all particles below 30 microns in diameter were captured. Calculations made on two fallout-size distributions and three radioactivity levels indicate no significant hazard from material collected on the shelter air filters. Side-opening blast-closure devices, such as the AMF and OCD units, require additional protection to keep fallout from being captured by the high velocities at the inlet. Shelters close to atomic blasts are likely to be subject to dangerous amounts of all sizes of particles coming from lower altitudes. These shelters must have all intakes closed during the danger period. (auth)

13606 ANALYSIS OF AXISYMMETRIC REDUNDANT STRUCTURES. Z. Zudans (Franklin Inst., Philadelphia). Nucl. Struct. Eng., 1: 159-85(Feb. 1965).

Based on the principle of complementary energy, a system of compatibility equations for axisymmetric structures was derived. Using the compatibility equations, an analysis method suitable for use with the digital computer and for hand computations was developed. Equations for analysis of most of the usually encountered types of free bodies are given. Methods for evaluation of matrix contributions are described, and a complete numerical sample is reproduced. Analyses as described were programmed at The Franklin Institute and successfully used for numerous reactor vessel, heat exchanger, and other axisymmetric structure analyses. (auth)

13607 PROCEEDINGS OF THE SYMPOSIUM ON SOIL-STRUCTURE INTERACTION, [TUCSON, ARIZ., JUNE 8-11, 1964]. Tucson, Ariz., Univ. of Arizona, 1964. 647p. (CONF-640614)

Thirty-six papers are included. Topics covered include: basis of current criteria for design of underground protective construction, wave propagation in soil media, ground motion and instrumentation, state of the art, similitude and model studies, analytical and experimental studies, and design and prototype studies. (M.C.G.)

Space Propulsion

Refer also to abstract 13844.

13608 (NASA-TN-D-2676) EXPERIMENTAL INVESTIGATION OF A CONSTANT-VELOCITY TRAVELING MAGNETIC WAVE PLASMA ENGINE. Robert E. Jones and Raymond W. Palmer (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Feb. 1965. 26p. $1.00(OTS).

The previously reported traveling magnetic wave plasma engine was redesigned to reduce the high heat loss to the tube walls downstream of the last magnetic-field coil. The present configuration uses a 3-inch-diameter pyrex tube flared out to a 6-inch diameter immediately downstream of the last magnetic-field coil. This configuration was studied to determine the effects of flared-tube geometry, molecular weight of the propellant, engine length, and use of a ferrite core on the engine performance. Argon and xenon gases were used as propellants. Two engine lengths were tested. One engine was nominally 1-magnetic-wavelength long (4 coils) and the other nominally $2\frac{1}{2}$-magnetic-wavelengths long (10 coils). The magnetic wave speed for

both of these lengths corresponds to a specific impulse of 4750 seconds. The maximum kinetic efficiency of the 4-coil engine was 10 percent at a specific impulse of 3200 seconds using argon gas and 22.5 percent at 4200 seconds using xenon gas as the propellant. Increasing the engine length had a negligible effect on the performance with argon gas; however, the increased engine length resulted in lowered performance with xenon gas. It appears that there may be an optimum engine length that will yield maximum efficiency for each propellant. The efficiency of the 4-coil engine with the ferrite core installed was significantly lower than that obtained when no core was used. Drag and heat losses caused by the core exceeded any positive effect produced by enhancing the radial component of the magnetic field. (auth)

13609 (NP-14777) ION ROCKET ENGINE DEVELOPMENT. Quarterly Progress Report No. 3. (Hughes Research Labs. Div. of Hughes Aircraft Co., Malibu, Calif.). Nov. 30, 1964. Contract NAS 3-4109. 96p.

Ion engine development was concentrated on the evaluation of a three-strip ion engine which used the Philips Mod. E ionizer material. The engine was tested with conventional accel electrodes as well as a vented double optic configuration. The engine test used only radiation cooling to maintain the focus electrode at a safe operating temperature; no supplemental means were used. Progress was made toward completion of the 20-strip, 15 to 22 mlb ion engine. A pump oil comparison indicates that the presently used Dow Corning 705 is markedly superior to the Octoil 20 for vacuum systems used in the testing of contact ion engines. An analysis compares the wedge, flat plate, and louvered types of collectors. Much less sputtered copper arrives at the ionizer from a comparably placed louver collector than from the other collector types. The 20-strip engine will require further improvements in the collector to minimize copper arrival to the ionizer. Work was continued on the evaluation of the potentialities of the use of alumina as a focus electrode. Trajectory studies were made with both the digital and analog computer to study the feasibility of using a knife edge nonemitting and emitting focus electrode. (N.W.R.)

13610 PROCEEDINGS OF THE CONFERENCE ON ARTIFICIAL SATELLITES, AUGUST 12 THROUGH AUGUST 16, 1963. Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser., 57: No. 8, Pt. C, 135p.(Aug. 1964).

Papers (5) are included on aerospace research; the communications satellite project relay; satellite data recovery and tracking, particularly for the Mercury program and the Gemini program; the information obtained from the Mercury program; and the design and uses of a manned orbital laboratory. (D.C.W.)

13611 PROCEEDINGS OF THE FIFTH INTERNATIONAL SYMPOSIUM ON SPACE TECHNOLOGY AND SCIENCE, TOKYO, 1963. Tsuyoshi Hayashi, ed. 1964. Distributed by AGNE Corp., Tokyo. (CONF-630903)

Papers (122) are included on national space programs, propellants, propulsion, space vehicles, systems engineering, space electronics, space science, space medicine and biology, and space law. (D.C.W.)

13612 EXPERIMENTAL ANALYSIS OF THE EXHAUST BEAM FROM A COLLOID THRUSTOR. Carl T. Norgren and Daniel S. Goldin (Lewis Research Center, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-674, 28p, $1.00. (CONF-640801-31)

From 4th Electric Propulsion Conference, Philadelphia.

A homogeneous-condensation type colloid thrustor was operated with mercurous chloride propellant and with accelerating voltages to 18 kilovolts. The exhaust beam was analyzed with a unique quadrupole mass filter. A single high intensity particle spectrum with a mass distribution of 0.72×10^7 to 1.38×10^7 atomic mass units per unit electron charge (amu/z) was detected when the propellant flow was in the continuum-flow regime. It was estimated that a loss in overall thrustor efficiency of less than 2 percent would be incurred due to this narrow particle spectrum. A low intensity of charged particles over the range of about 10 to 1×10^6 amu/z was detected in the slip-flow regime. No colloids were detected in the free-molecular regime. A theoretical study based on the liquid-drop theory of nucleation was used to correlate the colloid formation behavior. The data in this program are compared with previous data. It is shown that homogeneous condensation could provide the narrow amu/z distribution required for a high-performance electrostatic rocket. (auth)

13613 ELECTRODE MATERIALS FOR CONTACT ION ENGINES. Hugh L. Garvin and R. G. Wilson (Hughes Aircraft Co., Malibu, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-684, 26p, $1.00. (CONF-640801-32)

From 4th Electric Propulsion Conference, Philadelphia.

One factor limiting lifetime performance of contact ion engines is erosion of the electrode structures, especially erosion of the accelerating electrodes on surfaces facing the focusing electrodes. Examinations of ion and atom trajectories show that neutral cesium atoms evaporating from the porous tungsten ionizer tend to scatter from the accel electrodes and fall onto the focus electrodes which, because of their proximity to the ionizer, may be at a temperature sufficiently high to cause ionization. Experiments were performed to determine materials best suited for use in these electrode structures. Criteria are discussed for selection of electrode materials permitting maximum engine performance and lifetime, and results are presented of measurement of ion and electron emission characteristics for materials including copper, molybdenum, thoriated tungsten, platinum, tungsten, and molybdenum disilicide. (auth)

13614 A NEW CATHODE FOR MERCURY ELECTRON-BOMBARDMENT THRUSTORS. W. O. Eckhardt, J. A. Snyder, H. J. King, and R. C. Knechtli (Hughes Research Labs., Malibu, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-690, 13p, $1.00. (CONF-640801-33)

From 4th Electric Propulsion Conference, Philadelphia.

A liquid-mercury-cathode scheme is described, which provides a sufficiently long lifetime for electric-propulsion missions. The problem of maintaining the discharge voltage below the sputtering threshold of the cathode material is eliminated by operating the discharge in an arc mode, using a liquid-mercury surface as the cathode, and by using the removal of Hg atoms from this cathode by the discharge as the expellant feed mechanism. No separation is required between liquid and vapor phases in the feed system. It was experimentally demonstrated that open-pool Hg cathodes can be used in electron-bombardment ion sources, yielding simultaneously expellant mass utilizations >80% and power expenditures <500 ev/ion. It was shown that gravity-independent liquid-Hg cathodes are feasible. Improved designs of gravity-independent liquid-Hg cathodes furnished between 10 and 30 electrons/atom: (M.J.T.)

13615 CATHODE DURABILITY IN THE MERCURY ELECTRON-BOMBARDMENT ION THRUSTOR. William R. Kerslake (National Aeronautics and Space Administration, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-683, 32p, $1.00. (CONF-640801-34)

From 4th Electric Propulsion Conference, Philadelphia.

A mercury electron-bombardment ion thrustor was used to evaluate the performance and durability of four types of cathodes—refractory metal (tantalum and tungsten), oxide impregnated nickel matrix, lanthanum hexaboride surfaces, and units employing a thick oxide layer containing reinforcing wires. The most successful refractory metal was a tantalum ribbon cathode, which had a practical lifetime of 150 hours in a thrustor. Oxide-impregnated nickel-matrix cathodes failed in 189 hours or less because of the

environment of the ion discharge chamber. The lanthanum hexaboride surfaces failed after several hours and were abandoned in favor of the more promising thick-oxide-layer cathodes. The thick-oxide-layer cathode demonstrated a lifetime of 1660 hours in a simulated ion thrustor and 615 hours in a 10-centimeter-diameter thrustor operating at 0.25 ampere beam current with a net accelerating voltage of 4000 volts. In all cases the thick-oxide-layer cathode required five times less heating power per emitted ampere than the refractory metal cathodes. (auth)

Vacuum Engineering

13616 ELECTRON TUBE PROCESSING USING PORTABLE DIODE AND TRIODE GETTER-ION PUMP VACUUM SYSTEMS. D. G. Theodorou and R. O. McIntosh (Bendix Corp., Southfield, Mich.). 10p. (CONF-640903-5)

From American Vacuum Society Symposium, Chicago.

The principle of operation of a triode getter-ion pump is briefly described and the relative improvement in performance of the triode over the diode pump is reviewed. A compact, portable ultrahigh vacuum system design is also described that consists of an aluminum frame on which is mounted an 8-liter sec^{-1} diode or a 25-liter sec^{-1} triode getter-ion pump. A glass manifold, which is comprised of a liquid nitrogen trap and an ion gage, is coupled directly to the pump. Details of a method are given for reducing the pressure to the starting region of the getter-ion pumps and for tipping-off the high vacuum units from the roughing system. Finally, brief mention is made of maintaining the system and pumps. (auth)

GEOLOGY AND MINERALOGY

General

Refer also to abstracts 13859 and 14894.

13617 (CU-2663-13) ON A POSSIBILITY OF SIMPLIFIED MEASUREMENT OF TURBULENT DIFFUSION NEAR THE OCEAN BOTTOM. Takashi Ichiye (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Dec. 1964. Contract AT(30-1)-2663. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Vertical distributions of suspended matter which has been observed by Ewing and Thorndike at three deep stations on the continental slope southeast off New York with a new nephelometer are discussed from a point of view of turbulent diffusion of sediment particles. It is shown that theoretical curves obtained with eddy diffusivity which vanishes at the bottom and the top of a nepheloid layer, varying as a quadratic function of depth, do not agree with the observed distributions, though the model of eddy diffusivity has been proved to be suitable for suspended particles in an open channel. It is found that eddy diffusivity proposed by Rossby and Montgomery for the lower layer of atmosphere yields vertical distributions of concentration similar to those observed. The eddy diffusivity determined from curve fitting techniques consist of three parts: a lowest part linearly increasing with distance from the bottom, a middle part quadratically decreasing with distance and an upper part of a constant value. When settling velocity of suspended matter is taken as 3×10^{-5} (cm/sec), the ranges of eddy diffusivity determined at three stations are 0.1 to 1 (cm^2/sec) for the upper part and 0.6 to 36 (cm^2/sec) for the maximum values at the top of the lower part. Speculation on causes of transparent zones is presented. Origins of turbulence which produces boundary layers in adjacent to the bottom and residual eddy diffusivity in the upper part of the nepheloid layer are discussed. (auth)

13618 (NP-14667) THE APPLICATION OF RADIOACTIVE TRACERS IN THE STUDY OF SAND MOVEMENTS IN RIVERS. Vojislav Vukmirovic (Institut za Vodoprivredu "Jaroslav Cerni," Belgrade). [1963]. Contract No. 207/RB. 114p. Dep.(mn).

Tracer studies were carried out on bed-material discharge movement in the river Velika Morava near Ćuprija in Sept.-Oct. 1963 and June 1964. Natural sand which was surface-labeled with ^{51}Cr was used as the tracer. The results are given in the form of numerous graphs. The theory of stochastic processes is discussed and applied to the problem of bed-material discharge. (D.L.C.)

13619 (NYO-98-1) TECHNICAL REPORT, TASK 1: PROGRESS [ON TSUNAMI WAVE MEASUREMENT]. (National Marine Consultants. Div. of Interstate Electronics Corp., Anaheim, Calif.). Apr. 1964. Contract AT(26-1)-98. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

An evaluation is being made of various methods and systems for measuring tsunami waves in water depths to 18,000 feet. The design and expected performance of the proposed taut-wire buoy system are outlined, and a discussion of the expected signal-to-noise ratio is included. The feasibility of measuring the deep water waves from an aircraft using a radar altimeter is determined. The expected electromechanical configuration of the three instrumentation systems (deep water, atoll, and island) is discussed along with equipment shelters. The signal characteristics expected are summarized. The shipboard handling procedures are evaluated. (N.W.R.)

13620 ABUNDANCES OF THE FOURTEEN RARE-EARTH ELEMENTS, SCANDIUM, AND YTTRIUM IN THE SOLAR SYSTEM (IN METEORITIC, TERRESTRIAL, AND SOLAR MATTER). R. A. Schmitt (General Atomic Div., General Dynamics Corp., San Diego, Calif.), R. H. Smith, and Larry Haskin. p.583-621 of "Rare Earth Research II." New York, Gordon and Breach, 1964.

Available concentration or abundance data up to the present are presented and evaluated for the 14 rare earth elements (excluding Pm) plus Sc and Y in meteoritic, terrestrial, and solar matter. Emphasis is placed on the abundances of the rare earths, Sc, and Y in chondritic (or ordinary stony) meteorites because the chondritic meteorites are considered to be the best representative samples in the solar system of the abundances of the nonvolatile elements. 79 references are included. (P.C.H.)

Natural Radioactivity and Fallout

Refer also to abstracts 12911, 12956, 13127, 13690, 13691, 13692, 14115, 14116, and 14118.

13621 (BNL-7881) EXPERIMENTS TO TEST THE PRESENCE OF COSMOGENIC NUCLIDES IN OCEAN SEDIMENTS. O. A. Schaeffer, G. Megrue, and S. O. Thompson (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A search was made for evidence of extraterrestrial origin in the magnetic material separated from deep ocean red clay deposits. Negative results were obtained for ^{36}Cl, ^{3}He, and ^{21}Ne, and estimates are made of the extraterrestrial fraction. (D.L.C.)

13622 (CEX-59.4.10) AERORADIOACTIVITY SURVEY AND AREAL GEOLOGY OF THE NATIONAL REACTOR TESTING STATION AREA, IDAHO (ARMS-I). Robert G. Bates (Geological Survey, Washington, D. C. and Division of Biology and Medicine, AEC). Mar. 1963. 18p. Dep.; $1.00(OTS).

An airborne radioactivity survey was made of the area around the National Reactor Testing Station near Idaho Falls, Idaho. The survey area is a square, 100 miles on a side, centered on the Testing Station reservation. Parallel flight lines were flown in an east-west direction with a flight line interval of 1 mile and at an altitude of 500 ft above the ground. The area includes parts of three physiographic subdivisions. They are, from north to south, the Northern Rocky Mountains province, the Snake River Plain section of the Columbia Plateaus province, and the Great Basin section of the Basin and Range province. Owing to the rugged topography, only small parts of the Northern Rocky Mountains and the Great Basin sections within the survey area could be flown. In those parts flown, silicic volcanic rocks of Tertiary age have radioactivity levels as high as 2100 cps. On the Snake River Plain, radioactivity levels ranged from 200 to 1600 cps and averaged about 600 to 800 cps. Delineation of some recent lava flows by the radioactivity data is excellent. Increase in radioactivity level toward the center of a lava flow may be indicative of successive flows from a differentiating magma source. The radioactivity level of blocky lava flows is 50 to 100 cps higher than that of adjacent ropy flows. This is probably due to a greater emitting surface area per unit volume on the blocky flows rather than to any difference in mineralogical content. (auth)

13623 (CEX-59.4.24) AERORADIOACTIVITY SURVEY (ARMS-I) AND GEOLOGY OF THE GNOME (CARLSBAD) AREA, NEW MEXICO AND TEXAS. Jules A. MacKallor (Geological Survey, Washington, D. C. and Division of Biology and Medicine, AEC). Feb. 1963. 30p. Dep.; $1.00(OTS).

An aeroradioactivity survey of about 7000 square miles around the GNOME test site near Carlsbad, N. Mex., was made. The project was flown along east-west flight lines approximately 500 ft above the ground. Flight lines were one mile apart in the central part of the area and two miles apart elsewhere. Aeroradioactivity contacts on a map delineate areas of similar radioactivity. The radioactivity values, to which a cosmic correction has been applied, are shown in counts per second (cps), and have been corrected for deviations from the 500 ft surveying altitude. The GNOME area includes parts of three physiographic regions: the Llano Estacado and Pecos lowlands sections of the Great Plains, and the foothills and mountains. The Guadalupe Mountains lie west of Carlsbad, and the Delaware Mountains lie along the southwestern edge of the area. The radioactivity of the GNOME area is low and ranges from 50 to 600 cps. The Llano Estacado portion of the area ranges from 100 to 400 cps; the Pecos lowlands from 50 to 600 cps; and the foothills and mountains from 200 to 600 cps. Rocks of Permian age crop out extensively in the Guadalupe and the Delaware Mountains. The predominantly carbonate rocks in the Guadalupe Mountains have a radioactivity of 100 to 600 cps, but most are between 200 and 400 cps. The predominantly elastic rocks in the Delaware Mountains have a radioactivity of 250 to 550 cps, but most are between 350 and 500 cps. Rocks of Permian age crop out in the Pecos lowlands and have been divided into the Castile and the Rustler Formations. They are composed principally of anhydrite and carbonate rocks; but the Rustler contains some sandstone and siltstone. The Castile ranges from 50 to 450 cps, but most is 100 to 300 cps; the Rustler ranges from 200 to 500 cps, but most is 200 to 300 cps. The Ogallala Formation of Tertiary age was deposited by coalescing streams and consists mostly of sand, silt, and gravel. This formation is the bedrock of the Llano Estacado, and small outliers of the Ogallala occur in the Pecos lowlands. The radioactivity of the formation is 100 to 400 cps. A distinct radioactivity contact coincides with Mescalero Ridge, the Ogallala Formation east of the ridge being 100 cps higher than the Quaternary sand to the west. (auth)

13624 (FZK-187) FALLOUT RADIATION ENERGY DISTRIBUTION AS A FUNCTION OF ALTITUDE. T. W. De Vries (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). July 17, 1964. Contract OCD PS64 31. 357p. (AD-602492). $6.00(OTS).

The gamma-ray spectra in the air above a plane containing fallout fission products were calculated as a function of time and altitude. Similar calculations were made with the spectra of cobalt-60 and cesium-137 assumed as source terms. An experiment was designed to measure the spectra calculated for cobalt-60 utilizing eleven cobalt-60 sources and a very sensitive sodium-iodide gamma-ray spectrometer. The results of the calculations indicate that the relative spectra are constant above 800 feet for times after fission greater than one day and, furthermore, that the variation of the dose rate with altitude is constant for this time interval. (auth)

13625 (HW-SA-3392) THE ACCUMULATION OF FALLOUT CESIUM-137 IN NORTHERN ALASKAN NATIVES. W. C. Hanson and H. E. Palmer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 3, 1964. Contract AT(45-1)-1350. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The radioactivity due to fallout, particularly ^{137}Cs, in northern Alaskan Eskimos and Indians was measured in 1963 and 1964 with a portable whole-body counter. Results were analyzed in relation to the food habits of the various ethnic groups, age, sex, and season of the year. Eskimos of northern Alaska represent two major ecological groupings, the inland people who rely upon caribou (Rangifer articus) for most of their food and the coastal Eskimos who utilize sea mammals extensively and consume only moderate amounts of caribou and reindeer (R. tarondus). Natives of the Fort Yukon area who utilize moose (Alces alces) as a major food source were also measured. Intergradations of all groups occur among the Eskimos inhabiting the villages along the Noatak and Kobuk River systems in northwestern Alaska. Availability is the main regulator of food consumption and introduces important seasonal differences in utilization of food sources. Dietary information was obtained from the people at the time of counting and samples of native and imported foods were collected for radiochemical analysis. Comparison of results with results of measurements made in 1962 indicated increased ^{137}Cs body burdens in natives who had consumed large amounts of caribou and reindeer meat. The results also disclosed important differences in the ^{137}Cs content in plants and animals from various environments. The passage of ^{137}Cs from the atmosphere through lichen to caribou to man is discussed. (C.H.)

13626 (HW-SA-3742) AIR-BORNE RADIONUCLIDE MEASUREMENTS AND PHYSICAL CHARACTERISTICS DETERMINATION. R. W. Perkins, C. A. Thomas, and J. M. Nielsen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 15, 1964. Contract AT(45-1)-1350. 31p. (CONF-765-8). Dep.(mn); $2.00(cy), 1(mn) OTS.

From 2nd AEC Conference on Radioactive Fallout from Nuclear Weapons Tests, Washington, D. C.

Newly developed counting techniques which employ multidimensional gamma-ray spectrometry have been employed for the direct measurement of a large group of radionuclides in fallout samples. This spectrometric counting method has made it possible to study the distribution of many of the trace constituents of fallout and also to improve the precision for the measurement of the longer lived fallout radionuclides. The concentrations of ^{7}Be, ^{22}Na, ^{54}Mn, ^{60}Co, ^{85}Y, $^{95}Zr-^{95}Nb$, ^{106}Ru, ^{124}Sb, ^{125}Sb, ^{134}Cs, ^{137}Cs, and ^{144}Ce can be measured directly and their concentrations in air during the past $2^{3}/_{4}$ years are reported. The measured solubility of the fallout radionuclides is reported, and their deposition as dry fallout and as rain out is compared in the area of Richland, Washington. The distribution and movement of the tracer radionuclides ^{88}Y and ^{124}Sb both in the stratosphere and troposphere as well as that of ^{239}Pu are discussed. The cosmic-ray produced radionuclides ^{38}Cl and ^{35}S are mentioned and their application along with other cosmic-ray produced radionuclides in atmospheric research is considered. (auth)

13627 (NP-14708) SODERZHANIE TSEZIYA-137 V POVERKHNOSTNYKH VODAKH ATLANTICHESKOGO OKEANA I EGO MOREI V 1961 G. (Cesium-137 Content in Surface Water of the Atlantic Ocean and Its Adjacent Seas in 1961). P. M. Chulkov and V. F. Gorbunov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 6p. Dep.(mn).

Tabulated data on the content of ^{137}Cs in the Atlantic Ocean surface waters measured July, 1961 showed that along the thirtieth meridian at 20 to 30° latitude it was 8 to 30 counts/min per 100 l. Tables correlating the data on the radioactivity of the Atlantic Ocean, Black Sea, and Mediterranean Sea are included. (R.V.J.)

13628 (NP-14718) KONTSENTRATSIYA SUMMARNOI RADIOAKTIVNOSTI PRODUKTOV DELENIYA, A TAKZHE Ce^{141}, Ce^{144}, Zr^{95} + Nb^{95} I Cs^{137} V PRIZEMNOM SLOE VOZDUKHA V PODMOSKOV'E V 1960–1962 GG. (Concentration of Total Radioactivity of Fission Products and of ^{141}Ce, ^{144}Ce, ^{95}Zr + ^{95}Nb and ^{137}Cs in Ground-Level Air Near Moscow in 1960–1962). S. G. Malakhov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 13p. Dep.(mn).

Mean monthly and maximum concentrations of ^{141}Ce, ^{144}Ce, ^{137}Cs, ^{95}Zr, and ^{95}Nb radioactivity measured at the ground level during 1960–1962 are tabulated and analyzed. (R.V.J.)

13629 (NP-14778(Pt.III)) OFF-SITE SURVEILLANCE PROGRAM. PART III. RADIATION SURVEILLANCE NETWORK STATE OF HAWAII. 1962 Pacific Nuclear Tests

(Operation DOMINIC), March 1962 to November 1962. (Publich Health Service, Washington, D. C.). 72p.

Data are presented on the gross beta activities of air, water, and precipitation at different stations in Hawaii for the period April to November 1962. The stations include Lihue, Kaneohe, Kona, Kaunakakai, Hilo, Kahului, Mauna Loa, and Honolulu. (D.L.C.)

13630 (NP-14796) SODERZHANIE STRONTSIYA-90 V CHERNOM MORE V 1959-1961 gg. (Strontium-90 Content in the Black Sea in 1959-1961). V. P. Shvedov, S. A. Patin, A. M. Maksimova, and A. V. Aleksandrov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 8p. Dep.(mn).

Tabulated data are given on the content of ^{90}Sr in surface waters of the Black Sea region near Crimea (Cape Kikkeneiz) measured during 1959–1961. (R.V.J.)

13631 (TID-12616(Rev.2)) ATMOSPHERIC RADIOACTIVITY AND FALLOUT RESEARCH. Second Revision. (Division of Biology and Medicine, AEC). Dec. 1964. 132p. Dep.; $1.50(cy), 3(mn) CFSTI.

A descriptive account is given of the research program supported by the Division of Biology and Medicine. The objectives, needs, and content of the program are given. Individual summaries are given of the research under each contract, and publications are listed. (D.L.C.)

13632 DETERMINATION OF THE CONCENTRATION RATIO OF THE RADIONUCLIDES CERIUM-144 AND CESIUM-137 IN THE SOLID ATMOSPHERIC FALLOUT. V. Voljin (Univ. of Bucharest). Acad. Rep. Populare Romine, Studdi Cercetari Fiz., 15: 55-9(1964). (In Rumanian)

Fallout collected in Bucharest during the period from December 25, 1962 to February 12, 1963 was analyzed to determine its age on the base of the concentration ratio of ^{144}Ce and ^{137}Cs. The material was obtained as snow, collected at a height of 15 m above the ground. After filtration, the filter residue and the evaporated filtrate were calcined and subjected to γ spectrometry after a lapse of 30 days. Photopeaks were observed at 135 and 665 kev and one between 450 and 520 kev; a much weaker peak at 350 kev was noted only in the first 2 of the 5 samples. During the period in question the total air activity did not increase noticeably; therefore, the peaks had to be due to the long-lived nuclides. ^{144}Ce and ^{137}Cs were previously identified chromatographically in the fallout collected in Bucharest during this period. The 450 and 520 kev peak must be due to an unidentified mixture of radionuclides. Calculations based on the decay schemes of ^{144}Ce and ^{137}Cs revealed that the ratio $^{144}Ce/^{137}Cs$ stayed fairly constant, falling off slightly toward the end of the period, even though the total amount of the fallout decreased markedly. The ratios found in the five samples were: 0.91, 1.01, 0.92, 0.90, and 0.88. (TTT)

13633 RADIOACTIVE PRECIPITATION: CONTRIBUTION FROM RADIOACTIVE CLOUDS. J. Catala, R. Diez, J. L. Gomez, and R. Perez (Instituto de Fisica Corpuscular, Facultad de Ciencias, Valencia, Spain). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 60: 79-82(Mar.-Apr. 1964). (In Spanish)

Using a special rain gauge to collect separately eight fractions of rain water and measure the relative radioactivity of them, the atmosphere washing effect and the cloud contribution to the rain total activity were studied. (auth)

13634 INVESTIGATION OF AEROSOL RADIOACTIVITY. J. Catala, R. Diez, J. L. Gomez, and R. Perez (Instituto de Fisica Corpuscular, Facultad de Ciencias, Valencia, Spain). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 60: 83-7(Mar.-Apr. 1964). (In Spanish)

Measuring the activity of atmospheric dust, and using an autoradiographic method, aerosols of anomalous activity (hot particles) were found. The aerosol of most high activity was isolated and its absorption curve, decay, and gamma spectra were studied to identify the nature of the radionuclides. (auth)

13635 ANALYSIS OF THE EXPOSURE TO EXTERIOR PENETRATING ENVIRONMENTAL RADIATION OF THE POPULATION IN A RESIDENTIAL AREA (SÜDBADEN—SOUTH BADEN) IN DEPENDANCE ON THE GEOLOGICAL MILIEU. W. Herbst and G. Huebner (Universität, Freiburg i.B.). Atomkernenergie, 9: 457-62(Nov.-Dec. 1964). (In German)

The exposure of the whole population living in the inhabited area of South-Baden (W-Germany), comprising 975 communities with 1,641,453 inhabitants, against exterior penetrating environmental radiation was measured by means of an ionization chamber and scintillation counter registration. At the same time, the influence of the geological surroundings was studied in detail. The measurements were carried out during the time when the natural background radiation was increased most heavily so far by fallout radioactivity from nuclear weapons experiments. This increase amounted to about 60 mR/a during the summer 1963 on the average. In the zone of the Black Forest block massif 25% of the total population are settled. In this area 230 mR/a were measured on the average in 1963. Within the trias formation 11% of the inhabitants are exposed to 200 mR/a (140–240 mR/a), in the area of the jura formation 3% to 175 mR/a (130–210 mR/a), and on the surface layer of the quartär 61% also to 175 mR/a (100–230 mR/a) on the average. Five percent of the population live in areas with less than 125 and 5% with more than 250 mR/a. But only 0.4% are exposed to a radiation level of more than 300 mR/a. For 50% of the inhabitants the radiation level measured in 1963 was lower than 168 mR/a; if the estimated fallout peak is deducted, the level amounts to about 110–120 mR/a. (auth)

13636 HYDRODYNAMICS AND CONTENT OF TRITIUM IN THE WATERS OF THE EVIAN BASIN (FRANCE). Bernard Blavoux, Louis Glangeaud, Paul Leveque, and Philippe Olive (Faculté des Sciences, Paris). Compt. Rend., 259: 4323-6(Dec. 9, 1964). (In French)

The water nappe of Evian-Cachat has a flow velocity that can be measured by using tritium as indicator. The surface velocity is less than 100 m in 10 yrs. (tr-auth)

13637 THE DETERMINATION OF BODY BURDENS OF RADIONUCLIDES BY COMPUTER ANALYSIS OF γ-RAY SPECTRAL DATA. S. H. Cohn and E. A. Gusmano (Brookhaven National Lab., Upton, N. Y.). Health Phys., 11: 109-16(Feb. 1965).

The technique of γ-ray measurement by pulse-height analysis provides the most rapid and accurate determination of internally-deposited radionuclide abundances in man. Scintillation spectrometer pulse-height distribution data were analyzed to quantify the levels of ^{137}Cs, ^{65}Zn, ^{40}K and other radionuclides in 500 subjects. In a large-scale study of this kind, it was found desirable to employ automatic data-handling techniques, including computer analysis of the spectral data. The whole-body counter data of the subjects were compared with that obtained from a phantom (REMAB) containing standardized solutions of a number of monoenergetic gamma emitters. A number of FORTRAN II programs for the IBM-7094 were used for the reduction of the pulse-height distribution data. The programs first perform a non-linear least-squares fit of a Gaussian function to the data points in the spectrum photopeaks. The associated Compton distribution required in the stripping program is then computed by interpolation from an experimentally-derived matrix of seven monoenergetic gamma rays. Commencing with the highest energy, each designated photopeak and its associated Compton is subtracted off until the complex spectrum is analyzed. Other programs take the initial spectral data from the analyzer in the form of punched paper tape and convert it to magnetic tape for use in the above stripping programs. This technique described appears capable of providing rapid and accurate quantitative interpretation of pulse-height distribution data, applicable to the determination of body burdens of various radionuclides. It will be shown that the method is less subjective than the usual graphic method for interpreting spectral data. The accuracy attainable and limitations of this computer analysis will be discussed along with the results of

specific population surveys for estimating body burdens. (auth)

13638 RADIOACTIVE TRACERS IN OCEANOGRAPHY. NATURAL RADIO NUCLIDES IN THE OCEAN. F. F. Koczy (Univ. of Miami, Fla.). Intern. Union Geodesy Geophys. Monograph, No. 20, 1-9.

The distribution in the ocean of some of the radionuclides with relatively long life is discussed. Uranium seemed to have a rather constant value in regard to depth and horizontal distribution, except in particular basins where reducing environment or fast circulation changes the picture as compared with the open ocean. Thorium measurements are scarce. The measurements of Koczy, et al. and Goldberg, et al. indicated very small amounts of thorium in ocean water. An attempt was made to estimate the concentration of ^{230}Th and ^{232}Th in sea water by interference. The occurrence of ^{231}Pa in the sediment indicated the same to be true for that element, as shown by Sackett and by Rosholt, et al. This was used for an absolute age determination in sediments, because the ratio of ^{230}Th to ^{231}Pa is independent of variation of the uranium content in sea water and the variation of the rate of sedimentation. It was possible to date the glacial ages back to 175,000 years. The ^{226}Ra distribution was affected not only by the activity of organisms and the mixing in ocean water, but also by the specific chemistry of its mother product, ^{230}Th. (auth)

13639 DIFFUSION OF RADON IN SEVERAL NATURALLY OCCURRING SOIL TYPES. Gerald L. Schroeder, Hobart W. Kraner, and Robley D. Evans (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 70: 471-4 (Jan. 15, 1965).

Experimental values of the diffusion coefficient for ^{222}Rn in several naturally occurring soils are presented; 0.03 cm^2/sec appears to be a fair approximation of the true value for moderately dry, sandy soils. In at least the upper 30 cm of some soils convection and diffusion are the mechanisms which remove radon from these shallow layers. Concentrations of ^{220}Rn in several soil and rock environments are listed. (auth)

13640 MEASUREMENT OF THE RADIOACTIVITY OF AIR DUST IN THE AREA OF VIENNA. Gertrud Keck (Tierarztliche Hochschule, Vienna). Mitt. Oesterr. Sanitaetsverwaltung, 62: No. 12, 1-3(1961). (In German)

The long-lived radioactivity of the atmospheric dust was measured from March 1958 to May 1960. The methods used for sample collection, autoradiography, measurement of the long-lived β activity, and radiation analysis are briefly described. The values obtained are tabulated and discussed. (J.S.R.)

13641 MEASUREMENTS OF LONG-LIVED RADIOACTIVITY IN THE LOWER LAYERS OF THE TROPOSPHERE IN THE PERIOD FROM 1 SEPTEMBER TO 15 DECEMBER 1961. F. Ernst, G. Keck, O. Preining, W. Resch, J. Schedling, and M. Sedlacek. Mitt. Oesterr. Sanitaetsverwaltung, 63: No. 3, 3-15(1962). (In German)

The most essential elements of the sampling devices and measurement methods used in measurement of long-lived radioactivity in the troposphere from Sept. 1 to Dec. 15, 1961, in Vienna are briefly described. The results are given and briefly discussed with respect to β measurements on filter samples, β measurements on sedimentation and fallout samples, hot particles, grain size distribution, and γ and β spectrometric analyses. (J.S.R.)

13642 STRONTIUM-90 IN THE WATERS OF THE BALTIC SEA. Olli Paakkola and Aarno Voipio (Inst. of Radiation Physics, Helsinki). Nature, 205: 274(Jan. 16, 1965).

Levels and distribution of ^{90}Sr in Baltic Sea waters were determined from 48 samples collected during 1959-63. Values were generally 3 to 4 times higher than North Atlantic values for lower latitudes during 1959-60 and about 2 to 5 times higher than those found around Greenland and the Faeroes. The ^{90}Si/Ca ratio was so low that the contribution through the sea food chain to the ^{90}Sr content of man was considered negligible as compared with other food sources. (H.M.G.)

13643 GAMMA SPECTROMETRIC STUDY OF PRECIPITATION SAMPLES. Gertrud Keck (Tierarztlich Hochschule, Vienna). Naturwissenschaften, 51: 505(1964). (In German)

All dust particles larger than 1 μm occurring in precipitation were separated and a γ spectrometric analysis was made of the samples. From October 1962 to September 1963, in every 14-day collection period, precipitations were collected in plastic containers. The distribution of the γ emitters ^{141}Ce, ^{144}Ce, ^{103}Ru, ^{95}Zr, and ^{95}Nb was determined. The results complemented observations on the lack of ^{103}Ru in very active particles. It often occurs principally in very small particles. Acidification of the solutions altered distribution of ^{95}Zr and ^{144}Ce. (J.S.R.)

13644 ISOTOPE GEOLOGY INVESTIGATIONS OF THE METALLOGENY OF MIDDLE EUROPE. E. Kautzsch (Staatliche Geologische Kommission, Berlin), H. Birkenfeld, H. Huebner, Th. Kaemmel, and H. Zahn. Sitzber. Deut. Akad. Wiss. Berlin, Kl. Bergbau, Huettenwesen Montangeol., No. 3, 3-18(1962). (In German)

On the basis of lead isotopic analyses made by mass spectrometry, metallogenic correlations and relations between sedimentary and magnetic deposits and indications on the origin of the metal mixtures are reported. (J.S.R.)

13645 FELDER, STROME UND AEROSOLE IN DER UNTEREN TROPOSPHARE NACH UNTERSUCHUNGEN IM HOCHGEBIRGE BIS 3000 M NN. (Fields, Currents, and Aerosols in the Lower Troposphere According to Investigations in the Alps up to 3000 m Sea Level). Reinhold Reiter. Wiss. Forschungsber. Naturw. Reihe, 71: 629p.(1964).

Data gathered on air electrical phenomena since 1950 and on atmospheric radioactivity since 1956 in the Alps at altitudes up to 3000 m are compiled. The chain of measurement stations, the geographical location, and their instrumental equipment are described in detail. The dependence of the air electrical elements on meteorological states and processes at altitudes from 500 to 3000 m is discussed. Solar-terrestrial relations are given, and air radioactivity and ionization are considered. The results of investigations on atmospheric radioactivity and its effects on the earth's surface are reported. The results of quantitative chemical-radiological analyses of samples collected from 1958 to 1961 are also presented. The changes in the contamination of air, precipitates, and grasses after the resumption of nuclear testing in the atmosphere in the spring of 1961 are discussed. (J.S.R.)

Site Survey and Selection

13646 PROPOSAL FOR A SYSTEMATIC PROCEDURE FOR CHOICE OF REACTOR SITES. H. Luks (Kernforschungsanlage, Julich, Ger.). Nucl. Struct. Eng., 1: 239-50(Feb. 1965). (In German)

An attempt was made to develop a systematic procedure for guidance in site selection considering hydrologic, geologic, topographic, and meteorologic conditions, as well as parameters of population density distribution, interests of neighboring industries, agricultural use of the environments, and traffic situations. The task is to select in a systematic way, from a number of possible suitable sites the one representing an overall optimum. As illustrative examples some reactor sites in Germany were analyzed using the suggested procedure. (auth)

13647 A BETTER WAY TO EVALUATE NUCLEAR-SITE METEOROLOGY. G. J. Walke, E. W. Hewson, and G. C. Gill (Consumers Power Co., Jackson, Mich.). Nucleonics, 23: No. 2, 72-5(Feb. 1965).

A well-instrumented meteorological tower in conjunction with a series of smoke plume photography experiments is recommended for use in evaluating nuclear-site meteorology. Problems in a site study to determine diffusion potential are discussed. Cost estimates for the recommended meteorological study are listed. (M.C.G.)

Techniques and Equipment

13648 (NVO-1163-16) PREDICTIONS OF PEAK VALUES OF GROUND MOTION. (Beers (Roland F.), Inc., Alexandria, Va.). Mar. 3, 1964. Contract AT(29-2)-1163. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Graphs are presented which predict peak values for ground motions for hypothetical detonations of 100 and 1500 kt for three different geologic situations at Yucca Flat. Acceleration, particle velocity, and displacement are plotted. (D.L.C.)

13649 ARCHEOMAGNETISM AND CARBON-14 DATING. (A RESEARCH METHOD IN THE FIELD OF PALEOMAGNETISM). G. Atanasiu. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 37-42(1964). (In Rumanian)

Archeomagnetism, the study of the variations of the magnetic field of the Earth in historic and archeologic times, is based on the fact that fired clay articles retain a thermoremanent magnetism. Upon heating the paramagnetic clay which includes oxides of Fe, the material becomes ferromagnetic because of the formation of magnetite, Fe_3O_4; beyong the Curie point the magnetite loses its ferromagnetism but upon cooling, it is remagnetized in the magnetic field of the Earth. Archeomagnetic measurements are able to indicate the magnetic inclination and declination and curves may be obtained indicating these changes as a function of time. However, no data are available for the period from 400 to 1400 A.D. because no fired ceramics from that time period are available. In order to facilitate determination of the age of fired clay objects from this time period, a radiochemical method was developed. The age of the artifacts is determined on the basis of the ^{14}C content in the organic components, such as ashes, bones, etc. The archeomagnetic data thus obtained are valid only for Rumania where the objects were found. The materials thus examined included fired bricks from castles and churches in Transylvania, the dates of which can be documented historically, funeral urns, large grain bins, furnaces used for the manufacture of bricks, graves with skeletons and clay articles. A close collaboration was established between archeomagnetic experts and radiochemical laboratories specializing in ^{14}C dating, attempting to provide data for the period from 400 to 1400. (TTT)

13650 APPLICATION OF THE PHOSPHORESCENCE INDUCED BY X RAYS TO PETROGRAPHIC STUDIES. Pierre Leymarie and Jacques Gorau (Centre National de la Recherche Scientifique, Nancy). Compt. Rend., 259: 4079-81(Nov.30, 1964). (In French)

A procedure is described, which makes it possible to show some aspects of the texture and fissuring of rocks. The method proposed can contribute to the calculation of the mineralogic composition. The basis of the method is that some rocks acquire a phosphorescence sufficiently intense to impress films applied against a polished surface long after the irradiation has stopped. (J.S.R.)

13651 THE EXTENSION OF THE METHOD OF CONCORDIA GRAPHIC CALCULATION TO THE MEASUREMENTS OF ABSOLUTE AGES MADE WITH THE USE OF URANIUM MINERALIZATIONS. Claude Allegre (Groupe de Recherches Geochimiques Louis Barrabe and Laboratoire de Geologie Appliquee de la Sorbonne, Paris). Compt. Rend., 259: 4086-9(Nov. 30, 1964). (In French)

A model that makes it possible to interpret the age discordances obtained by radioactive non-equilibrium is presented. (tr-auth)

13652 ON THE DISCORDANCES OF AGES OBTAINED BY THE STRONTIUM AND ARGON METHODS. Claude Allègre and Gil Michard (Laboratoire de Géologie Appliquée de la Sorbonne, Paris and Faculté des Sciences, Reims, France). Compt. Rend. 259: 4313-16(Dec. 9, 1964). (In French)

A model making possible a discussion of the discrepancies in age estimations by strontium and argon methods is presented. A concrete case is discussed as an example. (tr-auth)

13653 INVESTIGATION OF UNDERGROUND STREAMS BY MEASURING THE BACKGROUND RADIOACTIVITY. T. Ochiai. Genshiryoku Kogyo, 10: No. 1, 73-7(1964). (In Japanese)

A method, under development since 1950, of determining underground water movement by measuring background radioactivity has been shown to be practical. The increase in and the precipitation of radioactive substances were found to be related to geological formations. A fracture dislocation of a stratum increases the rock fractures, resulting in movement of radioactive materials from the deep layers to the surface and an increase in background radioactivity. The radioactivity was measured by a G-M counter or scintillation counter with a NaI(Tl) crystal. Either stationary or variable points may be used. (TCO)

13654 THE THEORY OF THE BOUNDARY EFFECTS IN NEUTRON GEOPHYSICS. V. F. Zakharchenko (Inst. of Geophysics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 12, 1811-18(Dec. 1964). (In Russian)

Neutron distribution in a limited cylindrical geometry system was studied using the general formulation of the boundary problem in neutron measurements. An analysis is made of neutron distribution in homogeneous infinite media. An expression was derived for estimating the boundary effects in a cylindrical geometry of various neutron-neutron methods. (tr-auth)

13655 EXCESS RADIOGENIC ARGON IN FLUID INCLUSIONS. S. N. I. Rama (Carnegie Institution of Washington, D. C.) S. R. Hart, and Edwin Roedder. J. Geophys. Res., 70: 509-11(Jan. 15, 1965).

Most minerals, with the possible exception of micas, commonly contain fluid inclusions. It is shown that the argon contained in these inclusions may be considered a possible source of error in dating very young or low potassium minerals by the K-Ar method. (C.E.S.)

13656 DEVICES FOR RADIOMETRIC DETERMINATION OF SOIL BULK-DENSITY AND MOISTURE IN FIELD CONDITIONS. Marian Borowczyk, Jan A. Czubek, Bohdan Dziunikowski, Jerzy Niewodniczanski, and Andrzej Zuber (Zaklad Geologii Inzynierskiej Instytutu Geologicznego, Warsaw). Nukleonika, 9: 871-84(1964). (In Polish)

Six devices used for the determination of soil characteristics by the radiometric method are described. Included are here two densitometer models and one hydrometer model for measurements by insertion into holes drilled into the ground, also an absorption type densitometer and two surface-type meters, one for density, one for moisture. The construction and technical data are given for each; some of the instruments come in different sizes. They all contain a single-counter electric probe and they are based on the principle of measuring the absorption of scattered radiation: the densitometers measure the gamma radiation transmitted to the soil from a ^{137}Cs source specially installed, while the hydrometers measure the retardation of fast neutrons from a specially installed Po-Be source by hydrogen nuclei. All calibration is done against standard soil samples. (ATD)

13657 EVALUATION OF SELECTED RADIOISOTOPES AS GROUND-WATER TRACERS. Albert Ray Jennings. Thesis, College Station, Tex., Agricultural and Mechanical Univ., 1964. 57p.

A tracer moving through a porous medium is subjected to ion exchange and adsorption. The amount of ion exchange and adsorption of certain radioactive tracers can be reduced by the process of chelating the radioactive tracer with ethylenediamine tetra-acetic acid. Antimony-124, cerium-141, chromium-51, indium-114, ruthenium-103, and strontium-85 in chelate form were tested in vertical exchange columns filled with 20-30 mesh crushed illitic shale having an exchange capacity of 19 meq/100 g. The elution curves for the chelated radioactive tracers were compared to the elution curves of chloride pulses. Of the six chelated radioactive isotopes tested, chromium-51 is apparently the best tracer. In the shale-filled exchange columns chelated chromium-51

moved through the columns at a velocity of about 9.6 percent that of the chloride ion. Distribution-coefficient determinations were made under static conditions for the chelated radioactive tracers, and comparison of the values for static conditions with the distribution-coefficient values determined from the exchange column data shows that close agreement exists between the distribution-coefficient values. Experimental data indicate that it would be possible to determine the average water velocity within an aquifer by determining the arrival time of a chelated radioactive pulse peak in an observation well. (Dissertation Abstr., 25: No. 4, Oct. 1964).

13658 SEMICONDUCTOR JUNCTION DEVICE FOR MONITORING RADIOACTIVITY IN A WELL LOGGING SONDE. John T. Dewan (to Well Surveying Corp.). U. S. Patent 3,158,743. Nov. 24, 1964. Filed Feb. 23, 1961.

The radioactivity well logging apparatus described consists of a pressure-resistant housing adapted to be lowered through a borehole. The housing contains a neutron source and a radiant energy detector. The radiant energy detector is a junction-type semiconductor elongated in a direction transverse to its junction and supported with its elongated dimension extending radially of the housing. Means are coupled with the detector for deriving indications primarily representative of radiant energy incident upon the semiconductor in the radial direction. The semiconductor detector requires minimum space and minimum electrical circuitry, and use of the radial direction reduces borehole size effects. (A.G.W.)

Thorium and Uranium Minerals

13659 NASTURAN FROM THE METAMORPHIC OF SNIEZNIK KLODZKI (SUDETES). M. Banas (Akademia Gorniczo-Hutnicza, Krakow). Bull. Acad. Polon. Sci., Ser. Sci. Geol. Geograph., 12: 169-72(1964).

This U-bearing mineral originates from Kletno in the region of Snieznik Klodzki, in the Middle Sudetes. It occurs in a polymetallic mineral group in the contact zone called the Snieznik gneisses and crystalline limestones, adjacent to garnet-amphibolepyroxene skarns, coated with magnetite ore. The rocks are metamorphic of Pre-Cambrian age. A characteristic radioactive action of nasturan upon adjacent minerals may be observed, causing a zonal and spotted dark-purple coloring of the fluorite and loosening the coherence of the colored fluorite. Quartz showed a tendency to form a clouded variety, while calcite presented a pink hue. The nasturan examined crystallized in collomorphic shapes (spherical, kidney-shaped, or shelly), in sizes from fractions of a millimeter to 1.5 cm. On the basis of their reflectivity and microhardness, four varieties of the mineral were distinguished. X-ray analysis of the mineral yielded a result resembling the debyegram of synthetic UO_2. Results of the x-ray analysis confirmed that the polymorphic varieties of UO_2 are of similar crystalline form. A debyegram made of the variety corresponding to nasturan IV showed no crystalline structure, this in conformity with the opinion that with increasing ratio $UO_3:UO_2$ the crystalline structure vanishes. Chemical analyses and x-ray examinations showed that in nasturan the quantity of uranium diminishes, from 84.80% U_3O_8 in variety I to 75% U_3O_8 in variety IV, the SiO_2 content increasing from 1.46 to 12%. Among trace elements, the nasturan samples examined showed the presence of Th and Ta. In the oxidation zone, nasturan passes into secondary minerals. It is suggested that nasturan from Kletno was formed by hydrothermal solutions ascending from an unknown magmatic environment, or from hydrothermal solutions of metamorphic origin. (TCO)

13660 THE EXTRACTION OF URANIUM FROM SEAWATER. Comit. Nazl. Energia Nucl., Notiziario, 10: No. 12, 62-8(Dec. 1964). (In Italian)

The possibility of recovering uranium from natural water, including seawater, by means of ion-exchange resins is considered. (editor)

13661 CONCENTRATION OF RADIOACTIVE ELEMENTS IN DEEP CRUSTAL MATERIAL. K. S. Heier and J. A. S. Adams (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 29: 53-61(Jan. 1965).

Th, U and K were determined in paragneisses of different metamorphic grade. Both Th and U concentrations were lower in granulite facies rocks than in more low-grade metamorphic rocks of equivalent nature. Thus geological processes operating in the crust must result in an upward concentration of these elements. The Th/U ratio of the paragneisses showed a wide variation, which was related to the oxidation of U. Some evidence exists for a decrease of the Th/U ratios with metamorphic grade. (auth)

13662 X-RAY DIFFRACTION INVESTIGATION OF URANINITE FROM BHUNAS, RAJASTHAN. V. Amirthalingam (Atomic Energy Establishment, Trombay, India). Indian J. Pure Appl. Phys., 402-3(Dec. 1964).

Lattice parameter and crystallite size were accurately determined for uraninite from Bhunas. The higher value of the lattice parameter obtained indicated the presence of ThO_2 as solid solution. The crystallite size measurements revealed that crystallites are of anisotropic dimensions. (auth)

13663 VOPROSY GEOKHIMII RADIOAKTIVNYKH ELEMENTOV NEFTYANYKH MESTOROZHDENII. (Geochemistry of Radioactive Elements in Oil Fields). G. K. Efendiev, R. A. Alekperov, and A. N. Nuriev. Baku, Azerb. SSR, Izdatel'stvo Akademii Nauk, 1964. 151p.

Data are presented on the geochemistry of radioactive elements found in Azerbaidzhan oil deposits. Distribution of uranium in oil fractions, sorption of uranium and thorium in crude oil asphalts, petroliferous rocks, and in open water are discussed. 250 references. (R.V.J.)

HEALTH AND SAFETY

Refer also to abstracts 12898, 13605, 13637, 13903, 13956, 14858, and 14879.

13664 (CEX-63.7) A COMPARATIVE ANALYSIS OF SOME OF THE IMMEDIATE ENVIRONMENTAL EFFECTS AT HIROSHIMA AND NAGASAKI. Technical Progress Report. Clayton S. White, I. G. Bowen, and Donald R. Richmond (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). June 1963. Contract AT(29-1)-1242. 89p. Dep.; $2.00(OTS).

The problem areas of concern to those who would establish a quantitative relation between biologic response and the more immediate environmental variations caused by nuclear explosions were defined. The scope of blast and shock biology was set forth and a selective summary of current knowledge regarding biological blast effects was presented. Tentative criteria useful in assessing the hazards of some of the major nuclear effects were noted. Following elucidation of the range-yield-effects relationship applicable to high-yield explosions generally, the criteria were applied specifically to a 20-kt yield burst at heights assumed to apply to the Hiroshima and Nagasaki explosions. The procedure, establishing the range-effect relationships for the two Japanese cities, were carried out through use of the free-field scaling laws and a mathematical model allowing scaling of translational effects for both debris and man. Thus an attempt was made to predict the ranges inside which the potential existed for producing specified levels of biological damage. For each of the predicted ranges, values for overpressure, thermal and initial nuclear radiations along with translational velocities for man and glass fragments were computed to allow a more balanced appreciation of all the effects parameters that pose a hazard to man. The implications of the free-field range-effects data in interpreting some of the immediate effects at Hiroshima and Nagasaki were explored and discussed. Though the over-all analytical approach followed was thought to be useful and sound, the tentative nature of many of the numerical data presented was emphasized. (auth)

13665 (LA-3203-MS) IMPACT TESTS ON 20-INCH-CUBE BIRDCAGE-TYPE TRANSPORT CONTAINER (B. E. 1012). Horace Noyes (Los Alamos Scientific Lab., N. Mex.). Dec. 1964. Contract W-7405-eng-36. 15p. Dep.; $1.00(OTS).

The safety of a proposed universal container for the shipment of fissile material was evaluated by drop tests and by calculation of nuclear hazards. The container was found to be safe for planned loadings. (D.L.C.)

13666 (LA-DC-6866) PROBLEMS PERTAINING TO PACKAGING AND TRANSPORTATION REGULATORY STANDARDS APPLICABLE TO SHIPMENTS OF RADIOACTIVE MATERIALS. Horace E. Noyes (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 10p. (CONF-650103-1) Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

Regulations and organizations pertinent to the safety of packaging and transportation of radioactive materials are described. The problem of inexpensive but safe containers is considered. Classification of radioactive shipments is given. The need for amendments to regulations and for economical but safe shipments is pointed out. Results of an evaluation of fissile material shipment practices are described. (D.L.C.)

13667 (NP-1496) SODERZHANIE STRONTSIYA-90 V MOLOKE OTDEL'NYKH RAIONOV SSSR V 1960-1961 GG. PERVOI POLOVINE 1962 G. (Strontium-90 Content in Milk from Various Regions of the U.S.S.R. in 1960, 1961 and the First Half of 1962). P. M. Chulkov (U.S.S.R. Sovet Ministrov. Gosudarstevennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 10p. Dep.(mn).

Tables are given on the content of ^{90}Sr in milk and the effects of fresh fodder contamination measured monthly in collective farms of the Moscow, Vologda and Ryazan districts during 1960, 1961, and 1962. (R.V.J.)

13668 (NP-14780) CASUALTIES FROM NUCLEAR WEAPONS. A MANUAL FOR EMERGENCY HEALTH SERVICES. (Canada. Dept. of National Health and Welfare, Ottawa). 1964. 168p. Dep.(mn).

See NP-13568 for 1963 report.

Information is presented for the use of the several health professions engaged in the prevention and management of casualties produced by multi-megaton nuclear weapons. The physical principles of nuclear weapons are reviewed. Casualties are considered from the standpoint of those caused by blast, thermal radiation, initial ionizing radiations, and fallout. Available data are reviewed and estimates are presented of the various types of casualties expected under various conditions and at various post-attack times. During the first week it is expected that the patient workload will consist of traumatic and thermal injuries, during the second, third, and fourth weeks the acute radiation syndrome will develop, and after the fourth week communicable diseases are expected to present the major problem. The characteristics of fallout and radiation hazards from the internal and external deposition of fallout fission products are discussed. The problems presented by the contamination of food, milk, water supplies, drugs, and x-ray films by fallout are considered and decontamination procedures are outlined for food, milk, and drinking water. The importance of shelters and the protection provided by various types of structures are discussed. Results are included from a survey of Canadian hospitals in non-target areas. (C.H.)

13669 (NUS-156) NUS EFFECTIVE ENERGY PROGRAM. Y. S. Kim (Nuclear Utility Services, Inc., Washington, D. C.). Oct. 11, 1963. 14p.

The NUS Effective Energy Program is a digital computer program written for the IBM-7090 FORTRAN Monitor System to calculate effective energies absorbed by internal body organs due to disintegration of radioactive fission products inhaled and ingested by a human being. Internal organs considered in the program are the thyroid, bone, gastrointestinal tract and lung. Results are presented in units of Mev per disintegration of the parent nuclide in a given chain. Average running time for seventy fission product chains is about 13 minutes. (auth)

13670 (NVO-162-13) KIWI B1B REACTOR OPERATION. ON-SITE RADIOLOGICAL SAFETY REPORT. Bernard F. Eubank and C. R. Penwell, comps, and eds. (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). Sept. 1, 1962. Contract AT(29-2)-162. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The full-power test of the Project Rover Kiwi B1B reactor was conducted Sept. 1962 at the Nuclear Rocket Development Station near Mercury, Nev. During the test, portions of the fuel core were ejected from the reactor and some 50 acres around the test cell were contaminated. Pretest preparations for radiation surveys of the test site are reported. Results are reported from radiation measurements during cloud passage on an arc 5 mi from the reactor and at various ground locations during the first 8 post-operation days. A list of isotopes that contributed to the total activity is included. Road decontamination was carried out by washing with high-pressure water. Sizes of the core material ranged from identifiable to microscopic. Area decontamination activities consisted of the collection and disposal of all radioactive materials. (C.H.)

13671 (WASH-1052) NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM. Summary Report. (Division of Reactor Development, AEC). Nov. 1964. 93p. Dep.; $0.50(GPO).

Basic and applied research activities in reactor safety including reactor kinetics, fuel meltdown phenomena, fission product release, and reactor containment are summarized. Work on reactor kinetics is being devoted mainly to Special Power Excursion Reactor Test (SPERT). The characteristics of reactors and research in the SPERT program are discussed along with work on metal-water reactions, metal ignition and burning, fission products, reactor containment, and fast reactor safety. The programs in field testing are aimed at providing ways of demonstrating the safety and reliability of terrestrial and aerospace nuclear systems. Activities in these programs are summarized in sections on terrestrial systems, aerospace systems, and nuclear safety and recovery. Effluent control research is directed toward safe management and disposal of radioactive wastes and toward control of environmental radioactivity. Activities in these areas are summarized in sections on environmnetal studies, waste management, and gaseous and aerosol effluents. A discussion concerning the direction of nuclear analysis and evaluation projects is included. (J.R.D.)

13672 APPARATUS AND MEASURING TECHNIQUES FOR ENSURING COMPLIANCE WITH THE 1ST SSVO. S. Mueller (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Atomwirtschaft, 10: 27-32(Jan. 1965). (In German)

Fulfillment of the requirements demanded by the First Radiation Protection Regulation (1st SSVO) within the framework of German Atomic Legislation often gives rise to technical measurement difficulties. Particular problems in the assessment of the activity of water and the atmosphere raise the question as to which methods can be used for measurement of the highest permissible concentration values assigned to non-analyzed mixtures. A concentration value of $1 \times 10^{-7}\mu$ Ci/cm^3 is fixed for radioactive materials or mixtures of such materials in water, which are not analyzed. This regulation cannot be realized in principle for reasons of measurement technology. It demands measuring equipment that would cover all occurring kinds of radiation in an equal manner. Further, determination of the activity must be completely independent of the kind and energy and even of the emission probability of the radiation. However, from the standpoint of radiation protection a method of measurement had to be found, which is as simple as possible and which continuously and rapidly indicates possible danger. It is shown that it is sufficient to discover methods of measurement that cover the concentration values of all the possible radionuclides that can occur in water. If monitoring is limited to these radionuclides then not only is the financial expenditure held within tolerable limits but safety is also increased. It was concluded that continuous monitoring, which covers only that which is necessary, contributes more to safety than a very exact but occasional investigation of individual specimens taken at random. (auth)

13673 NUCLEAR HAZARDS AND THE CANADIAN PUBLIC. Hugh C. McIntyre. Can. Nucl. Technol., 4: 44-7(1965).

A general review of radiation effects on living organisms is presented, and some implications in the development of nuclear applications are discussed. (R.E.U.)

13674 CONCERNING THE MAXIMUM PERMISSIBLE CONCENTRATION OF URANIUM IN WATER AND AIR. V. P. Shamov (Leningrad Scientific-Research Inst. of Radiation Hygiene). Gigiena i Sanit., No. 11, 104-11 (Nov. 1964). (In Russian)

The International Commission for Radiological Protection considered both the radioactivity and the toxicity of U when establishing the MPC values. For the ^{230}U to ^{236}U isotopes and radioactivity was the important factor but in the case of the long-lived isotope ^{238}U and for the natural isotopic mixture ($^{238}U_I - ^{234}U_{II}$) the chemical toxicity was the limiting consideration. A body burden of 1 mg in the kidney was taken as an acceptable value for the kidneys for occupation exposure. The MPC values of the soluble U compounds in air were tabulated for the natural isotopic mixture and for 7 specific isotopes, indicating in every case the critical organ (such as kidneys or bone marrow) involved. Similar tabulations were made for insoluble compounds and for MPC values in water. For natural U, the occupational exposure value is $(MPC)_{air} = 14 \times 10^{-14}$ Curie/liter, corresponding to 0.2 mg/m^3. For the population at large, this value is further divided by 100. The recommended $(MPC)_{water}$ value for the population amounts to 0.6 mg/liter, thus it is 12 times higher than the value taken by the USSR (0.05 mg/liter). (TTT)

13675 EFFECT OF PRECIPITATION ON THE CONCENTRATION OF RADIOACTIVE AEROSOLS OF ARTIFICIAL ORIGIN. Antal Simon. Idojaras, 68: 151-7(May-June 1964).

The concentration of artificial radioactive aerosol particles was monitored at the Aerological Observatory (Aerologiai Obszervatorium) in Budapest-Lorinc. The data obtained during the past few years are presented and discussed. A relation was found between the concentration and atmospheric phenomena. The β activity of the aerosols was significantly affected by experimental detonation of nuclear-type weapons in the course of testing. Precipitation phenomena, coupled with certain self-purifying features of the atmosphere, contributed to the dissipation and decay of radioactive aerosol particles. (OTS)

13676 RADIOPROTECTION AT THE SACLAY CENTRE D'ETUDES. Henri Joffre. Ind. At., 8: No. 11, 43-55(1964). (In French)

The essential purpose of radioprotection is summarized, and criteria for the organization and operation of a radioprotection service are given. The detectors commonly used for the detection of external radiation and radioactive contamination are briefly described. The physical aspect of the dosimetry of external radiation is treated more fully. Study of the requirements in the dosimetry of external radiation leads to certain practical conclusions on the construction and use of dosimeters adapted to the measurement of the absorbed dose. The devices used for monitoring radiation in the vicinity of nuclear installations are discussed and their use is indicated. (tr-auth)

13677 RADIOPROTECTION AT THE ORSAY FACULTE DES SCIENCES. Paul Bonet-Maury (Centre National de la Recherche Scientifique, Paris). Ind. At., 8: No. 11, 57-66 (1964). (In French)

The history, organization, and operation of the radioprotection Service of the Radium Institute, which ensures the safety of the greater part of the personnel of the large accelerators and laboratories, are outlined. (tr-auth)

13678 SAFETY WITH RADIOISOTOPES. Sula J. Marsalis (Mississippi State Coll. for Women, Columbus, Miss.); and E. E. Beauchamp. Isotopes Radiation Technol., 2: 172-81(Winter 1964-65).

Safety in the handling of radioisotopes is discussed, and the hazards are related to those of other items of commerce. Safety precautions used in radioisotope processing and shipping are described. Safety in utilization of the isotopes and in waste disposal is also considered. (M.C.G.)

13679 AN ANALYSIS OF ACCIDENTS WITH RADIOISOTOPES, 1945-1962. Doris J. Yates (Univ. of Tenn., Knoxville and Oak Ridge National Lab., Tenn.). Isotopes Radiation Technol., 2: 181-5(Winter 1964-65).

Accidents in which radioisotopes were involved in the years 1945 through 1962 are listed, and causes are considered. Rules for safety orientation of employees are suggested. Methods of selling the public and radioisotope safety are discussed. (M.C.G.)

13680 RADIOACTIVITY. Brian Windeyer (Meyerstein Inst. of Radiotherapy, London). J. Roy. Inst. Public Health Hyg., 26: 45-8(Feb. 1963).

The author reviews uses and properties of radioactivity and ionizing radiations in general. The first organization

for radiological protection in the world was the British X-ray and Radium Protection Committee. Until the end of the second world war, the use of ionizing radiations was almost exclusively the province of a small part of the medical profession and a few scientists engaged in fundamental studies. With the increased use of ionizing radiations it has become important not only to protect individual workers from somatic effects but to ensure the protection of the population as a whole from the much smaller doses which would cause alterations in the germ cells of the gonads. There has gradually been built up a system of radiological protection on both an international and a national basis. The International Commission for Radiological Protection was set up by the International Congress of Radiology in 1928 and has continued as an unofficial nongovernmental organization, although it has official relations with the World Health Organization. The International Labor Office, Euratom, the controlling authority for the European Common Market countries, and the International Atomic Energy Agency, an agency of the United Nations, are others. In Britain the Medical Research Council has the duty of setting basic standards of max permissible levels. The Radioactive Substances Act in 1948 set up a statutory committee, the Radioactive Substances Advisory Committee, an interdepartmental body which has the task of advising the relevant government department on any matter of radiological protection and of co-ordinating the protection arrangements of the departments. It produced a Code of Practice for the protection of persons working in hospitals, and is revising this as a Code for Medical and Dental Practice to be issued by the Ministry of Health. It is producing another Code for Research Laboratories under the aegis of the Ministry of Labour. This Code is designed to apply to all research laboratories, including those of Government agencies, the Atomic Energy Authority, the Universities and Medical Schools, and research establishments in industry. The whole concept of protection has been built on the basis of max permissible levels of the Inter-Nation Commission. These levels have been set low because there are still many gaps in the knowledge of the biological effects of certain doses. Results of this policy is that occupational exposure to ionizing radiation is much less dangerous than mining, quarrying, and fishing and is perhaps about the same as the distributive trades, and less than automobile driving. (BBB)

13681 BALANCE OF ZINC IN JAPANESE PEOPLE AND DIET WITH REFERENCE TO ENVIRONMENTAL CONTAMINATION WITH RADIOACTIVE ZINC-65. Noboru Yamagata and Kiyoshi Iwashima (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 11: 131-8(Sept. 1962).

Measurements were made of the stable zinc in total diet samples collected from several sites to determine the normal daily ingestion of this element by average Japanese. Two thirds of urban adults should take 6–16 mg (11.0, on average), rural adults, 8–27 mg (17.5, on average), and rural children, 4–10 mg (7.1, on average). The daily intake by the Japanese adults as a whole was roughly estimated as 14 mg per person. The main contributors of zinc in Japanese diet are cereals, pulses, and nuts. Their percentage contribution was estimated as approximately 60% as a whole. This is in contrast to the North American diet in which almost three quarters of total zinc are contributed by meat, eggs, poultry, and milk products. The pattern of zinc contribution by foods has a close relation with the protein sources in Japanese diet of which 64.6% of the total is derived from cereals, pulses, and nuts. Biological half life of radiozinc was estimated as 915 days for Japanese on the basis of assumed existence of an equilibrium condition between the stable element and radiozinc. Current status of environmental contamination with zinc-65 was also referred, especially, of fishes from the Pacific Ocean and an estimation was made of the total body burden as being of value in the preliminary planning of radiological protection following the release of radioactivity. (auth)

13682 FALLOUT IN NEW ZEALAND: THE RESULTS TO JUNE, 1961. H. J. Yeabsley and I. P. Gregory (Dominion X-ray and Radium Lab., Christchurch, New Zealand). New Zealand Med. J., 61: 247-58(May 1962).

The establishment of a fallout program for monitoring air, water, and soil in New Zealand and its dependent island territories for radioactive contamination is discussed. New Zealand, in the mid-latitudes of the Southern Hemisphere, receives more stratospheric fallout than equatorial regions but receives very much less than the mid-latitudes of the Northern Hemisphere where most of the bomb testing has taken place. A comparison of the total monthly ^{90}Sr fallout in each hemisphere showed that in the Northern Hemisphere there is a marked seasonal variation with a maximum in the spring and that the main peak occurred a few months after the cessation of testing late in 1958. Much lower fallout occurred in the Southern Hemisphere. Towards the end of 1960, fallout dropped markedly in the north and became approximately the same in each hemisphere. At the end of 1960 New Zealand soil contained about 17 mC/mi^2. At this time the New York City accumulation was over 80 and at Milford Haven (Great Britain) over 50. Thus soils have less than one-third of the ^{90}Sr burden that exists in the Northern Hemisphere. Average contamination in N. Z. milk in 1959 did not reach the higher levels found in the Northern Hemisphere because stratospheric fallout was less. On the other hand, no marked decline was seen in milk contamination as shown for the Northern Hemisphere during 1960, and it appears that with the decrease in the rate of fallout in the Northern Hemisphere there has been a transfer of some stratospheric fission material across to the Southern Hemisphere. With the approximately equal rates of deposition in each hemisphere at the end of 1960, milk contamination in each hemisphere will become nearly the same. (TCO)

13683 SOME PROBLEMS OF RADIOLOGICAL PROTECTION IN PLUTONIUM AREAS. B. A. J. Lister (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Nippon Genshiryoku Gakkaishi, 6: 666-9(Nov. 1964). (In Japanese)

The value for the maximum permissible amount of plutonium for humans has varied since the first established value of 1944. At the present time 0.04 μc or about one-half microgram is the most widely accepted value. One of the approaches to determine the amount of plutonium ingested is sampling of environmental air. Problems associated with sampling techniques and justification for this form of measurement are given. Because of the long biological half life of this element in man (about 200 years in bone), the effects of ingested plutonium will extend for the rest of the victim's lifetime. The ultimate fate in the body of ingested plutonium depends on whether the material is in water soluble or insoluble form. Injected plutonium locates in the bones and liver. Because of the toxicity and relative chemical activity of this element, special precautions are necessary in its handling. Handling methods and precautions are discussed with figures on permissible working limits. Critical accidents are described with comments on measures to be taken after such an incident. Other types of accidents are discussed, and a summary of incidents that have occurred at Harwell in the period 1955-1959 is given. (TTT)

13684 DECONTAMINATION FACTORS OF THE FILTRATION PLANT OF WARSAW CITY. Ryszard Szepke, Danuta Grzybowska, Boguslawa Dobrzanska, Zuzanna Blazewska, Zofia Oszywa, and Elzbieta Trusewicz (Central Lab. for Radiological Protection, Warsaw). Nukleonika, 9: 891-6(1964).

Decontamination factors studied at the Warsaw municipal filtration plant over the period 1960–1962 are presented. All hydrological and hydrobiological data of the Vistula River are tabulated and statistically evaluated. Samples were obtained from the pumping station and then behind one of the slow filters. The decontamination factor was defined as the ratio of the logarithmic means of radioactivities between river water and drinking water. The value thus obtained was 1.4 overall. The mean values and standard deviation for the individual contaminating substances were also compiled with either logarithmic or arithmetic normal distribution. In addition, the correlation between

the decontamination factor and various hydrobiological parameters of the Vistula River was determined. (ATD)

13685 CALCULATION OF THE ABSORBED DOSE IN SOFT-TISSUE CAVITIES IN BONE IRRADIATED BY X-RAYS. J. L. Howarth (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Radiation Res., 24: 158-83(Jan. 1965).

A simplified method is presented for the calculation of the absorbed dose in soft-tissue cavities in bone. The method takes into account the variation of LET with electron energy and extends the analysis of Charlton and Cormack to spherical cavities; it also takes into account the continuous-energy spectrum of the Compton electrons, and the energy transferred to the medium by Auger electrons. The computation of the geometrical functions and physical parameters involved is described, and accurate tabulations of these quantities are presented. (auth)

13686 SPHERICAL CONTAINMENT VESSEL FOR A NUCLEAR POWER STATION. Giovanni Popoli. Riv. Ital. Saldatura, 16: 152-8(May-June 1964). (In Italian)

Fabrication details, including surface preparation, submerged arc welding, and nondestructive testing, are described for the production of spherical containment vessel operating at 1.83 atm and 120°C. (Rev. Metal Lit., 21: Dec. 1964)

13687 PARTICLE SIZE FRACTIONATION OF AIRBORNE GAMMA-EMITTING RADIONUCLIDES BY GRADED FILTERS. Bernard Shleien, Thomas P. Glavin, and Albert G. Friend (Public Health Service, Winchester, Mass.). Science, 147: 290-2(Jan. 15, 1965).

Three filters in series were employed to separate into groups, according to size, the nuclear debris suspended in air at ground level. The concentrations of airborne $^{144}Ce-^{144}Pr$, ^{125}Sb, ^{137}Cs, $^{95}Zr-^{95}Nb$, ^{54}Mn, and $^{106}Ru-^{106}Rh$ in each size group were determined by gamma spectral analysis. Particles having diameters of less than 1.75 microns contained a minimum of 88% of the total activity. (auth)

13688 VOPROSY RADIATSIONNOI BEZOPASNOSTI PRI KHRANENNI I PEREVOZKE RADIOAKTIVNYKH IZOTOPOV. (Problems in Radiation Protection during Storing and Transporting Radioactive Isotopes). A. V. Terman. Moscow, Publishing House "Meditsina," 1964. 135p.

A systematic survey is made of protective measures for storing, and transporting radioisotopes. Descriptions are given of the design and construction of equipment for handling, storing, and transporting radioactive materials within the building (plants, hospitals, or laboratories) and in transport. Exposure standards and radiation protection regulations are discussed. Measures for preventing accidents during transportation are reviewed. Extensive references are included. (R.V.J.)

13689 CIVIL DEFENSE. PROJECT HARBOR SUMMARY REPORT. A Report by a Summer Study Group at Woods Hole, Massachusetts. Publication 1237. (National Research Council. Summar Study Group, Woods Hole, Mass.). 1964. 44p. $1.25(NAS, Washington, D. C.)

A group study was made of civil defense problems. The likely effects of various kinds of attack on U.S. were examined, and the technologies of civil defense were considered both independently and in conjunction with military defense systems. The six-week meeting was divided into six panels: Acceptance and Impact, Education and Training, Strategy and Tactics, Future Weapons and Weapons Effects, Immediate Survival, and Postattack Recovery. (D.L.C.)

13690 UNWELTRADIOAKTIVITÄT UND STRAHLENBELASTUNG. BERICHT I/63. (Environmental Radioactivity and Radiation Burden. First Quarterly Report, 63). Bad Godesberg, Ger., Bundesminister für Wissenschaftliche Forschung, 1963. 158p. 8,00 DM.

The results of the measurements of the radioactivity in air, water, earth, and foods and the radiation burden of the population in the West German Republic were reported for the first quarter of 1963. The measurements were tabulated. (J.S.R.)

13691 UNWELTRADIOAKTIVITÄT UND STRAHLENBELASTUNG. BERICHT II/63. (Environmental Radioactivity and Radiation Burden. Second Quarterly Report, 63). Bad Godesberg, Ger., Bundesminister für Wissenschaftliche Forschung, 1963. 176p. 8,00 DM.

The results of the measurements of the radioactivity in air, water, earth, and foods and the radiation burden of the population in the West German Republic were reported for the second quarter of 1963. The measurements were tabulated. (J.S.R.)

13692 UNWELTRADIOAKTIVITÄT UND STRAHLENBELASTUNG. BERICHT II/64. (Environmental Radioactivity and Radiation Burden. Second Quarterly Report, 64). Bad Godesberg, Ger., Bundesminister für Wissenschaftliche Forschung, 1964. 172p. 8,00 DM.

The results of the measurements of the radioactivity in air, water, earth, and foods and the radiation burden of the population in the West German Republic were reported for the second quarter of 1964. The measurements were tabulated. (J.S.R.)

13693 UNIVERSITY OF ALABAMA MEDICAL CENTER RADIATION SAFETY PROCEDURES. (Alabama. Univ., University. Radiation Control Office). June 1, 1964. 72p. (Free, Radiation Safety Office, Univ. of Alabama).

Radiation safety procedures of the University of Alabama Medical Center, Birmingham, are outlined. The center uses radioisotopes, x radiation, and other forms of ionizing radiation. (C.H.)

13694 INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT FIFTH ANNUAL MEETING, PITTSBURGH, PENNSYLVANIA, MAY 4, 5, AND 6, 1964. Columbus, Ohio, Institute of Nuclear Materials Management, 1964. 70p. (CONF-620). $5.00.

Fourteen papers are included on: principles of NMM used by AECL; total cost of quality; status of proposed transportation regulations; NMM in the assurance of nuclear safety; economics of shipping irradiated fuels; federal-state program of AEC and the use of nuclear materials in Kentucky; criteria for nuclear material inventory control; AEC contractual arrangements for handling special nuclear material; single system replacement of current lease-station arrangement; single accountability system; ASA activity in nuclear standards field; standardization in the nuclear field; standards activities of the Division of NMM; and AIF activities in the development of nuclear standards. (P.C.H.)

13695 VOPROSY DOSIMETRII I ZASHCHITY OT IZLUCHENII. VYPSUK 3. (Problems in Dosimetry and Protection Against Radiation. Issue 3). V. I. Ivanova, ed. Moscow, Atomizdat, 1964. 197p.

Twenty six articles are included on the dosimetry and protection against radiation. Problems in gas radiometry, energy spectrum characteristics of photoneutrons emitted from uranium targets, intermediate energy neutron dosimeters, and field emission from point monodirected sources are discussed in several articles. The techniques of spectrometric measurements development of spectra and calculations of γ field emission in infinite media, at the outlet of cylindrical step-like channels, and on the surface of semi-infinite media were analyzed as well as the problems of protection against high-energy cosmic protons. Electron dosimetry, bremsstrahlung from alpha reactions in light materials, and neutron fields after passing through cyclotron shielding were also investigated. (R.V.J.)

13696 THE RESUSPENSION OF PARTICULATE MATERIAL FROM SURFACES. K. Stewart (Atomic Weapons Research Authority, Aldermaston, Berks, Eng.). 26p. (CONF-555-5)

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964.

One of the processes by which particulate material deposited on a surface can give rise to a hazard is by resuspension in the atmosphere followed by entry into the human body by inhalation. The airborne concentration was found to

depend on the two rate processes of resuspension and redeposition and in consequence was expected to decrease markedly with height except possibly for very small (submicron) particles. The coagulation or agglomeration of the deposited aerosol with inert dust particles normally present on surfaces, particularly when the former is in essentially sub-micron in size, may mean that the properties of the resuspended material are those of the inert dust present because this is likely to predominate in terms of amount of material. Two factors that may account for the apparent observed differences between indoors and outdoors are the surface roughness and the degree of air movement, and associated turbulence, in the atmosphere. In general, outdoors the surface roughness is more marked and this can cause a lower resuspension rate than over the smooth surfaces normally present in laboratories. Indoors the air currents produced by ventilation and convection can lead to a continual entrainment of dust from smooth surfaces. The lines on which a general theory could be developed, are indicated. The results obtained from a variety of field experiments are presented and a simple method of estimating the likely significance of resuspension in terms of contamination levels is proposed. (auth)

INSTRUMENTATION

General

Refer also to abstracts 13204, 13205, 13575, 13994, 14123, and 14162.

13697 (AERE-R-4777) A NON-FEDBACK AMPLIFIER SYSTEM YIELDING HIGH GAIN STABILITY. M. O. Deighton (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Dec. 1964. 13p. Dep.; $0.50(BIS), 2s. 6d.(HMSO).

A redundant arrangement of two amplifiers, which continues to operate even when either one of the amplifiers has failed, is analyzed theoretically in the case where both amplifiers are operative. It is shown that the overall stability and linearity of gain is then considerably superior to that of either amplifier individually. The system thus appears to offer some of the advantages of negative feedback, but without the stability problems associated with a closed loop. The high-frequency and transient responses of the combination are examined in some detail; it is found that the latter generally exhibits overshoot, but may be corrected by a suitable output network. A brief appraisal of the noise performance of the system suggests that noise arises chiefly in one of the two amplifiers, the performance of the other being much less critical. (auth)

13698 (AFSWC-TDR-62-148) CONCEPTS FOR ON-STRUCTURE SHEAR GAGE AND ON-STRUCTURE SELF-RECORDING STRESS GAGE. Final Report. J. R. Stagner and R. Obenchain (United Geomeasurements. Div. of United ElectroDynamics, Inc., Pasadena, Calif.). Aug. 1963. Contract AF29(601)-4366. 92p. (AD-422753). $8.60(OTS).

Various concepts for the measurement of normal and tangential loads at the buried structure/soil medium interface are described. The concepts are evaluated in the light of basic criteria for load measuring devices, accuracy, and reliability under the anticipated testing environments and projected cost. Among the concepts explored are gages based on piezo resistivity, optical effects, magnetic effects, and brittle coatings. Preliminary designs for a peak normal load magnetic gage and a variable reluctance shear gage are presented. (auth)

13699 (BDX-613-59) THE AUTOMATIC BIAS AND FLUX-RESET OF A MAGNETIC MODULATOR (thesis). Jim L. Taylor (Kansas Univ., Lawrence). May 1964. Contract AT(29-1)-613. 153p. Dep.(mn); $5.00(cy), 3(mn) OTS.

The operation of a low-power magnetic modulator using two solid-state diodes and a resistor to provide the bias necessary for unipolar operation is investigated. The nonlinear modulator input characteristics were studied theoretically by a piecewise-linear analysis. (T.F.H.)

13700 (BNL-7830) RANGE AND ERROR OF DENSITOMETERS FOR EMISSION SPECTROSCOPY. Morris Slavin (Brookhaven National Lab., Upton, N. Y.). [1960]. Contract AT(30-2)-Gen-16. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The errors in measurement of spectral energy, due to scale errors of the transmission-type densitometer, have been evaluated. It is shown that the range of measurement is a direct function of the permissible errors. (auth)

13701 (DP-863) ULTRASONIC LIQUID LEVEL INDICATOR. T. Richard Herold and Leslie E. Goodwin (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Feb. 1964. Contract AT(07-2)-1. 18p. Dep.; $1.00(OTS).

An ultrasonic reflection technique is described for measuring static or turbulent liquid levels. Although originally developed for closed metal tanks containing process solutions of uranium, plutonium, and fission products, the technique is generally applicable to almost any environment. The ultrasonic transducer, which is positioned vertically by a servo drive, detects the liquid-air interface and controls the drive by means of the difference in reflectivity of the surrounding medium. A potentiometer coupled to the drive indicates the liquid level on a recorder. In the prototype instrument, the readout accuracy was ±0.025 cm over a 46-cm range. (auth)

13702 (HW-81984(p.7.1-26)) INSTRUMENTATION AND NONDESTRUCTIVE TESTING. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Development work on the PRTR automatic controller monitor, a regenerating neutron flux detector, a ^{11}B in-core neutron flux detector, and a microwave neutron flux monitor is reported. In nondestructive testing research, work is reported on an electromagnetic tubing tester, a hydride detector for Zircaloy-2, and on ultrasonics methods. Development work on an ultrasonic transducer for use in testing of fuel sheath tubing is also described. (J.R.D.)

13703 (HW-83606) PROGRESS IN INSTRUMENTATION RESEARCH AND DEVELOPMENT. A Summary of Hanford Laboratories Achievements in These Programs Under General Electric, 1951-1964. D. C. Worlton, W. G. Spear, R. A. Harvey, G. E. Driver, J. T. Russell, and B. B. Brenden (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1964. Contract AT(45-1)-1350. 54p. Dep.; $3.00(cy), 1(mn) OTS.

Developmental activities directed toward nucleonic instrumentation, optics, systems analysis and analog simulations, and control and data systems are summarized. Included are summaries of developments at Hanford concerning radiological instrumentation, radiobiological instrumentation, meteorological instrumentation, reactor instrumentation, chemical process instrumentation, and research instruments. A bibliography of 159 references is included. (J.R.D.)

13704 (NYO-2910-6) APPLICATIONS OF ULTRASONIC ENERGY— ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. BiMonthly Progress Report No. 18, August 1–September 30, 1964. (Aeroprojects, Inc., West Chester, Penna.). Oct. 1964. Contract AT(30-1)-2910. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An acoustic thermometer using an "Inor 8" sensing rod has been assembled, and preliminary thermal distribution measurements have been made. An improved method for phase-angle readout has been devised. (auth)

13705 (RADC-TDR-64-207) MILLIMETER WAVE COMPONENT DEVELOPMENT (BEAM-PLASMA AMPLIFIER). Paul Chorney and Richard J. Madore (Microwave Associates, Inc., Burlington, Mass.). July 1964. Contract AF30(602)-2948. 38p. (AD-603264). $2.00(OTS).

Data show that a plasma frequency of 140 Gc can be obtained at approximately 3.0 amp in xenon gas at a pressure of 40×10^{-3} Torr. The design of a BPA (Beam-Plasma Amplifier) study vehicle for experiments at 2 mm is described. The basis for the design and the salient points of the mechanical construction are also pointed out. The construction of E-plane and H-plane bends, are described, as well as that of a sliding short. The output of the 4-2 mm doubler was improved by 2.7 db with the use of the rejection filter. (auth)

13706 (UCRL-11702) INSTRUMENTATION MODULE SYSTEM. Dick A. Mack, Leo Schifferle, and Clayton A. Van Den Heuvel (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 25, 1964. Contract W-7405-eng-48. 69p. Dep.; $3.00(OTS).

A versatile system of constructing modular plug-in units is described, together with its associated bin and

interconnecting wiring. These units conform to the standard recently developed and adopted by the AEC Committee on Nuclear Instrument Modules. (auth)

13707 (UCRL-12040) RELIABILITY AND FAILURE OF ELECTRONIC EQUIPMENT, SYSTEMS, AND MATHEMATICAL MODELS: A BIBLIOGRAPHY. Carlotta M. Vidoni (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 1964. Contract W-7405-eng-48. 60p. Dep.; $3.00(cy), 2(mn) OTS.

A bibliography is presented, consisting of about 460 references to material on reliability and failure of electronic equipment and systems, and mathematical models for reliability and failure of these systems. (T.F.H.)

13708 (CEA-tr-R-1763) QUELQUES PROBLÈMES DE LA THÉORIE DES JAUGES D'ÉPAISSEUR–β POUR LES MESURES DE REVÊTEMENTS. (Some Problems in the Theory of β Thickness Gages for Measurements of Coatings). G. G. Iordan and Yu. M. Ovchinnikov. Translated into French from Priborostroenie, No. 3, 7-10(1963). 21p. Dep.(mn); $2.60(fs), $0.83(mf) JCL.

The basic formula describing the functioning of a β gage is analyzed, and it is shown that it is possible to judge in principle the concrete conditions necessary to the measurement and calculation of the base parameters of the gage apparatus. The isotope activity necessary for the optimum operation in a given thickness range is determined. Sources of errors are derived, and the causes for the variation of the saturation current in the coating and the support are given. (J.S.R.)

13709 INSTRUMENTS FOR DETECTION OF EXTRATERRESTRIAL LIFE. Anal Chem., 37: 29A-35A (Feb. 1965).

Extraterrestrial life detection experiments are discussed. These include the Multivator, Gulliver, Mars biological microscope, and optical activity detectors. The Multivator is based on the assumption that there is a negligible probability that there are non-aqueous, non-carbonaceous, or non-solvated forms of life on Mars. It permits many kinds of biological experiments to be carried out, particularly those that can be arranged to use a photomultiplier as an output transducer. Gulliver is an instrumented radioisotopic experiment designed to detect life on Mars. Gulliver is based on the same assumptions and limitations as the Multivator, and further presumes that, if life exists on other planets, microorganisms make up an important part of the biosphere. The Mars biological microscope consists of a lens system, a collection system, an illumination system, and a vidicon camera. The microscope will be able to collect dust particles during the 10 min required for its descent from a satellite as well as after it lands on Mars. (P.C.H.)

13710 ON THE IMAGING PROPERTIES OF THE HOMOGENEOUS-FIELD MAGNETIC HEAVY-PARTICLE SPECTROGRAPHS. Martti Bister (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 153, 1-50(1964).

The imaging equations of magnetic heavy-particle spectrometers with homogeneous field and straight-edged pole pieces were derived by examining a family of curves. An explicit expression for approximate effects of the fringing field is also presented. The conditions for obtaining a plane focal surface and second-order focusing simultaneously were examined. The design of a broad-range spectrograph of a new design is described. The derived equations were applied to a Fowler-type spectrograph. It is shown that the spectrograph, with possible minor alterations, yields a plane focal surface, even when a quadrupole lens is added in order to increase the transmitted particle yield. The maximum radius of curvature of the constructed spectrograph is 38 cm, the maximum magnetic field about 11000 G, and the best resolving power R_F measured was 1800. The solid angle of the analyzer is about 1×10^{-2} sr. (auth)

13711 HYDROGEN MASER AND CESIUM BEAM TUBE FREQUENCY STANDARDS COMPARISON. H. E. Peters (Varian Associates, Beverly, Mass.), J. Holloway, A. S. Bagley, and L. S. Cutler. Appl. Phys. Letters, 6: 34-5 (Jan. 15, 1965).

Direct frequency comparisons between a hydrogen maser and a cesium beam tube frequency standard are summarized. (D.C.W.)

13712 HYDROGEN MASER FREQUENCY COMPARISON WITH SWISS CESIUM ATOMIC BEAM STANDARD. H. E. Peters (Varian Associates, Beverly, Mass.) and P. Kartaschoff. Appl. Phys. Letters, 6: 35-6(Jan. 15, 1965).

Direct frequency comparisons between a hydrogen maser and the 4-m cesium beam tube of the Laboratoire Suisse de Recherches Horlogeres are summarized. (D.C.W.)

13713 NUCLEAR INSTRUMENTATION. NO. 21. Bull. Inform. Sci. Tech. (Paris), No. 85, Suppl., 1-45(July-Aug. 1964). (In French)

The design and specifications of the amplifiers and preamplifiers, counting devices, radiation detection instruments, and measurement devices recently developed by the CEA are reported. The devices reported include amplifiers with linear or logarithmic response for d-c current, preamplifiers with low noise, a transistorized device for dating with the ^{14}C method, a mobile station for atmospheric monitoring, an atmospheric monitor for the fluorine ion, a device for the control of the radioactivity of waters, atmospheric telemeasurements of monitoring stations of the Paris region, a variable delay generator, a helium leak detector, a continuous infrared detector with interferential filter, and measurement centralizing. (J.S.R.)

13714 PREDICTION, ACCELERATION AND CORRECTION OF FATIGUE EFFECTS IN PHOTOMULTIPLIER TUBES. I. Cantarell and I. Almodovar (Puerto Rico Nuclear Center, Mayaguez). Intern. J. Appl. Radiation Isotopes, 16: 91-5(Feb. 1965).

Practical methods for correcting the effects of fatigue in photomultiplier tube measurements are discussed. Also, a method is presented for reducing the time required for the saturation or stabilization of phototubes from several hours to a few minutes. Two methods are proposed for the correction of fatigue effects. One method proceeds from the experimental predictability of fatigue effects by means of plots or empirical equations with a margin of error of 1%. The other method proceeds from the synchronized measurement of fatigue together with the spectrum measurement. (auth)

13715 LOCALIZATION OF BOUNDARIES BETWEEN RADIOACTIVE AND INACTIVE SOLUTIONS BY A SCREENING METHOD. G. Marx and W. Schulze (Freie Universitat, Berlin). Kerntechnik, 7: 13-17(Jan. 1965). (In German)

A method has been developed for localizing boundaries between radioactive and inactive solutions by means of G.M. and scintillation counters. The position of the boundary is detected by using screens fastened to the detectors. Screens made of perspex have proved to be useful for locating boundaries marked by beta emitters. $\beta + \gamma$-rays are absorbed by "sandwich screens" consisting of three layers, e.g., Al-Pb-Al. Screens made of lead are used for filtering gamma rays. The best geometry of the screens was found by test series. Under certain conditions calculations permit the choice of proper material of the screens. The consistency of measured values and the precision of the results are discussed. (auth)

13716 INSTRUMENT FOR MEASURING ELECTRON CONCENTRATION IN PLASMA. E. A. Stakhov. Priborostroenie, 7: 3-8(1964). (In Russian)

A super-high-frequency interferometer for the measurement of electron concentration in plasma, which contains a gas discharge tube modulator, is described. The modulator makes it possible to obtain a considerable frequency shift, which effectively improves the time resolution of the interferometer. The block-diagram of the instrument is shown, and its operation is described. (auth)

13717 A FLUX STABILIZER WITH VIBRATOR INTENSIFIER. Joerg Kummer (Universität, Frankfurt am Main). Z. Angew. Phys., 18: 139-42(Dec. 15, 1964). (In German)

A flux stabilizer for a high-resolution nuclear resonance spectrometer is described. The direct voltage amplifier

necessary for the detection of low flux oscillations is a chopper amplifier to which an alternating voltage amplifier is connected in parallel to expand the band width. By suitable counter-coupling of the flux current to auxiliary coils and magnetic power supplies, a control factor of 10^4 was obtained for frequencies under 0.3 Hz. The decrease of the control factor was so slow that at 50 Hz it was still 10. How the control circuit appeared when separate counter-coupling coils were given up is described. (tr-auth)

13718 AN AUTOMATIC CONTROL AND REGISTERING INSTALLATION FOR A FIVE-CHANNEL PULSE HEIGHT ANALYZER. Alfred Schaarschmidt (Universität, Frankfurt am Main). Z. Angew. Phys., 18: 164-7(Dec. 15, 1964). (In German)

The control and registering installation described is used for automatic operation of a five-channel pulse height analyzer with window amplifier and running registration of the measurement values. The key programming using channel and window switches permits a wide latitude in the preselection of the program (voltage preselection for programs for measurement and testing purposes, removal of one spectrum with different channel width or doubling of the measurement time in individual ranges, and overlapping of windows or channels). The individual apparatus can be used separately for the most part, which is an advantage in institutions with limited equipment space. Simultaneous counting and recording of five different measurement sites is also possible as is the control of an integral or single-channel discriminator with writer or printer. Recording of the switching positions by code numbers, variable numbering, and breakdowns of the measurement values by groups, as well as parallel operating recorders with supplementary side markings facilitates the evaluation of the spectra and serves for continuing control. Through the possibility of different apparatus combinations the installation can be introduced not only in multiple forms in combination with the five-channel pulse-height analyzer, but also in other switching and recording tasks. (tr-auth)

Radiation Detection

Refer also to abstracts 12910, 13023, 13414, 13418, 13677, 14469, and 14855.

13719 (AD-423701) REMOTE READING INSTRUMENT FOR FALLOUT SHELTERS. (Lionel Electronic Labs., Inc., Brooklyn, N. Y.). July 1963. 64p. $2.00 (OTS).

Results are presented of efforts to develop a simple low-cost remote reading ratemeter with a gamma range to 1000 r/hr for use with small fallout shelters. The design objectives are low cost, small size, light weight, ease of calibration, simplicity of operation, reasonable ruggedness, and long shelf life. Remote capability to 100 feet is desired. (auth)

13720 (AD-424856) LOW-COST PERSONNEL DOSIMETER. (Bendix Corp., Cincinnati). July 26, 1963. Contract OCD-OS-62-165. 117p. $10.10(OTS).

The design and development are reported of a quartz-fiber low-cost dosimeter to meet OCD Specification CD V-742. Lower cost consistent with the specification was achieved by simplifying and improving the basic Bendix dosimeter design, using plastics for component parts, minimizing direct labor, and making the instrument suitable for automated processing and assembly. (auth)

13721 (AD-603608) A DOSIMETRY SYSTEM FOR THE FLASH X RAY (thesis). Ward F. Petrie (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1964. 133p. (GSP/Phys/64-12). $4.00(OTS).

A dosimetry system for the Flash X-ray, which is a pulsed radiation source, was sought. A system must meet the criteria which the Flash x-ray's characteristics dictate. These are energy independence in the range 40 kev to 600 kev, dose-rate independence in the range 10^7 to 10^9 r/second and sensitivity as low as 100 mr. All systems were eliminated except the LiF thermoluminescent dosimeter. A design for a reader was obtained from Los Alamos Scientific Laboratories. It was modified and the resultant reader was a more simple design, but still made a more flexible system. The system was checked out and was found to function very well. In particular, the system had a range from 100 mr to 500 r and better than 1% linearity in response. Recommendations on further work and improvements for the system were made as a result of this work. These included the areas of checking the actual dose-rate and energy independence, several system refinements, and data conversion. (auth)

13722 (AERE-R-4386) ON THE CHARACTERISTICS OF A COMMERCIAL PROTOTYPE DESIGN OF THERMOLUMINESCENT DOSIMETER. R. L. Otlet and E. W. Clipsham (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Nov. 1963. 37p. Dep.(mn).

The calibration of the energy sensitivity of thermoluminescent dosimeters enclosed in a number of prototype design of holders (filters) was carried out. Radionuclides were used for γ rays in the region 145 kev–2.76 Mev, together with an x-ray machine to cover a range down to 20 kev. Although with the original holders a marked energy dependence was observed, considerable improvements were made with later designs. Reports on observations of reproducibility, production tolerances and linearity of response etc., taken in the course of the energy sensitivity measurements, are also included. (auth)

13723 (HW-84329) NEUTRON DETECTOR SHIELDING IN A REACTOR BACKGROUND ENVIRONMENT. O. K. Harling (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1964. Contract AT(45-1)-1350. 12p. Dep.; $1.00(OTS).

A study is made of the performance of boron carbide, boric acid, water, and cadmium, and mixtures of these substances, as shielding for BF_3 neutron detectors in reactor environments. It is found that mixtures are more effective than single materials as shielding. (T.F.H.)

13724 (LAL-1118) MESURES MAGNETIQUES ET DETERMINATION DES CARACTERISTIQUES OPTIQUES DES DEUX SPECTROMETRES DE LA SALLE DE CIBLES 500 Mev DE L'ACCELERATEUR LINEAIRE D'ORSAY. (Magnetic Measurements and Determination Optical Characteristics of Two Spectrometers in the 500-Mev Target Room of the Orsay Linear Accelerator). J. Dupin (Paris. Université, Orsay. École Normale Supérieure, Laboratoire de l'Accélérateur Lineaire). Oct. 1964. 125p. Dep.(mn).

The experimental results obtained on the two spectrometers of the 500-Mev target room are reported together with a complete description of the methods used for the study of the particle deflecting electromagnets. A precise magnetic study is first made of the electromagnets, followed by an accurate study using the wire method. The electron bundle method completes or corroborates the previous methods. A method for the calculation of the second-order terms, in particular of the angle of the upright image with the image axis and of angular and chromatic aberrations, is given. These calculations correspond very well with experimental results. For the wire method a calculation of the correction term due to the weight of the wire is proposed and given results in very good agreement with experience. (J.S.R.)

13725 (LNF-64/51) STUDIO DI UN SISTEMA DI SCANNING DI FOTOGRAMMI DA C. A S. CON ACCOPPIAMENTO CRT-GRANDE CALCOLATORE. (Study of a System of Scanning Scintillation Photograms with CRT–Large Computer Coupling). Note No. 262. B. Bertolucci and F. Pandarese (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Oct. 12, 1964. 12p. Dep.(mn).

As an introduction, the general characteristics of automatic systems and scintillation chamber scanning are

briefly reviewed. Two systems operating in connection with the IBM 1620, 7040 computers with random-access type scanning were studied. The general characteristics of the CRT-31/IBM-7040 system were given. The system components—the IBM-7040, interface, CRT-31, and monitor systems—were described. The time and logic sequence in the operation of the system was discussed. (J.S.R.)

13726 (NARF-63-16T) NUCLEAR-INDUCED AIR-IONIZATION CURRENTS. P. R. Cheever (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Mar. 31, 1964. Contract AF33 (657)-7201. 63p. (FZK-9-190; AD-606674) $3.00(OTS).

The results of an analytical and an experimental investigation of ionization currents for pairs of parallel cylindrical electrodes subjected to 2×10^5 r/hr of cobalt-60 radiation are compared. Two electric-field assumptions were used to derive two ionization-current equations. Fair agreement was achieved between measured and calculated values. The effects of pressure, voltage, electrode diameter, and electrode separation are illustrated in numerous ionization curves. (auth)

13727 (NP-14691) USTROISTVA UPRAVLENIYA MATRICHNOGO TIPA DLYA MNOGOKANAL'NYKH ANALIZATOROV. (Matrix-Type Control Units for Multi-Channel Analyzers). A. F. Belov, S. S. Kurochkin, and D. A. Sterligov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 12p. Dep.(mn).

Descriptions are given of the design, construction, and performance of matrix-type control units for multichannel analyzers. Two types of control systems were developed for the multichannel and multidimensional analyzers AI-1024, AI-2048, AI-4096, and AI-1600. (R.V.J.)

13728 (NP-14695) ELEKTRONNO-FIZICHESKAYA APPARATURA NANOSECUNDNOGO DIAPAZONA. (Electronic-Physics Apparatus in the Nanosecond Range). P. S. Chernov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). [1962]. 9p. Dep.(mn).

A survey is given of the development of amplifiers, discriminators, coincidence and anticoincidence instruments with nanosecond range performance. (R.V.J.)

13729 (NP-14714) VKHODNYE USTROISTVA MNDGOKANAL'NYKH I MNOGOMERNYKH ANALIZATOROV. (Input Systems for Multi-Channel and Multi-Dimensional Analyzers). I. S. Krasheninnikov, S. S. Kurochkin, E. I. Rekhin, V. V. Eldashev, R. S. Efimchik, and A. S. Tuchina (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). 1963. 26p. Dep.(mn).

A survey is made of the development and performance of transistorized and tube type multichannel and multidimensional amplitude transformers. Transformer amplitudes, the number code, the linear condenser discharge taken at various temperatures, and comparative characteristics are discussed. (R.V.J.)

13730 (NP-14721) O PRIMENENII POLUPROVODNIKOVYKH DETEKTOROV YADERNYKHIZLUCHENII V SERIINOI APPARATURE. (The Use of Semiconductor Nuclear-Radiation Detectors in Mass-Produced Instruments). V. V. Matveev and Yu. P. Sel'dyakov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). [1962]. 12p. Dep.(mn).

Studies of semiconductor nuclear radiation detectors indicated the highest resolution with 5.5-Mev to 13-kev α particles and 660- to 6.5-kev electrons. The design of the spectrometer and electronic equipment used for amplification and development of the obtained pulses are described. (R.V.J.)

13731 (NP-14722) AMPLITUDNOE RAZRESHENIE STSINTILLYATSIONNOGO SPEKTROMETRA BYSTRYKH NEITRONOV S MONOKRISTALLOM LiI(Eu). (Amplitude Resolution of a Fast-Neutron Scintillation Spectrometer Using a LiI(Eu) Single Crystal). G. V. Miroshnikov and A. I. Kirillov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). [1963]. 7p. Dep.(mn).

Amplitude resolution and relative luminosity of LiI(Eu) crystal spectrometers equipped with a photomultiplier tube were studied. The amplitude resolution for 0.6, 0.8, 1, 1.5, 2, 2.5, 3, and 14-Mev neutrons derived from the reaction $T(p,n)^3He$ and $T(d,n)^4He$ was found to be ~ (27 to 30%) for 3-Mev neutrons and 19% for 14-Mev neutrons. The amplitude distribution curves as a function of maximum crystal luminosity yield are given. The maximum yield was observed with the α particle emission in the opposite direction from the neutrons. Energy distributions between α particles and tritons for the $^6Li + n \rightarrow {}^4He + {}^3T + 4.78$ Mev reaction calculated on the basis of energy and pulse conservation laws were tabulated. The table indicates a very slight variation in α-particle energy from the thermal neutron energy to 6 Mev (indicating a nearly linear relation V(E)). A considerable deviation from the linear law was observed with 14-Mev neutrons when the α particle energy increased by a factor of 2. Straggling of amplitudes and deviation from the linear law indicate weak LiI(Eu) luminosity for α particles. (R.V.J.)

13732 (NP-14775) IZMERENIE I IZOTOPNYI ANALIZ AEROZOLNOI ALFA-AKTIVNOSTI S POMOSHCHYU IMPULSNYKH IONIZATSIONNYKH KAMER. (Measurements and Isotopic Analysis of Aerosol Alpha Activity by Means of Pulse Ionization Chambers). V. F. Bolotin and O. A. Chutkin (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). [1963]. 11p. Dep.(mn).

A survey is given of published data on the use of ionization chambers for detection, indentification, and measurement of small concentrations and isotopic composition of α-active aerosols. The data showed that it is possible to determine α-active aerosols to 10^{-19} C/l with a simultaneous isotopic analysis (separate recording of ^{234}U, ^{235}U, ^{238}U, ^{239}Pu, ^{210}Po etc.). (R.V.J.)

13733 (NRS-23) CONSTRUCTION AND PERFORMANCE OF A FAST TIME-TO-AMPLITUDE CONVERTER. J. Bell, S. J. Tao, and J. H. Green (New South Wales Univ. of Technology, Kensington). 1964. 29p. Dep.(mn).

A subnanosecond time-to-amplitude converter based on the pulse overlap principle and including a pair of fast transistorized single channel analyzers for side channel pulse discrimination is described. The presence of machine background and natural background in addition to the random background is discussed. A high degree of stability and linearity is achieved. The machine time resolution is about 0.12 nsec, and when it is coupled with a pair of RCA6810A photomultipliers the total resolution is less than 0.7 nsec. (auth)

13734 (NRS-25) TIME MATCH OF PULSES AND TIME RESOLUTION OF A TIME-TO-AMPLITUDE CONVERTER. S. J. Tao, J. Bell, and J. H. Green (New South Wales Univ. of Technology, Kensington). 1964. 23p. Dep.(mn).

The theory of matching of the time pulses and the double coincidence pulses for a time-to-amplitude converter is discussed and extended. The time spread introduced by the phosphor, photomultiplier, gamma spectrum, and other factors is analyzed. (auth)

13735 (ORNL-P-993) THE RESPONSE OF SOME ORGANIC SCINTILLATORS TO FAST NEUTRONS. V. V. Verbinski, J. C. Courtney, W. R. Burrus, and T. A. Love (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 40p. (CONF-654-34). Dep.(mn); $2.00(cy), 2(mn) OTS.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

N-213 organic scintillators were calibrated for use in fast-neutron spectroscopy. Monte Carlo calculations were carried out, and pulse-height distributions were obtained for monoenergetic neutrons from 0.2 to 14.7 Mev. Light responses to protons, alphas, and carbon recoils were also derived. The resolution of N-213 for 14-Mev neutrons was also obtained. Tables of detector efficiency and pulse height distributions are included. (D.L.C.)

13736 (SC-TM-64-1674) X- AND γ-RAY MONITOR. W. F. Windle (Sandia Lab., Albuquerque, N. Mex.). Nov. 1964. Contract [AT(29-1)-789]. 28p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

Results are given of a feasibility study of an x-ray monitor capable of operation for 5 to 10 years without any maintenance. The x-ray sensor makes use of a NaI(Tl) scintillator coupled to a biplanar photodiode as the sensing element and a sensing circuit powered by a krypton-85 nuclear cell. The response of this system to ^{60}Co and ^{137}Cs gamma radiation and 600-kvp flash x ray is given. Suggestions for an improved system are also presented. (auth)

13737 (UCRL-7688) FOUR-DECADE COUNT-RATE METER WITH RESOLUTION OF ONE DECADE FOR SPACE FLIGHT. Stan Thomas (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 4, 1964. Contract W-7405-eng-48. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The most efficient use of telemetry channels is always a paramount problem of space flight projects. Monitoring radiation fields in space often requires coverage of large ranges of count rate which, if count-rate meters are to be used, means either a decrease in resolution due to coverage of the entire range with one rate meter or use of several telemetry channels if several different rate meters are used. A unique method permitting the desired resolution to be obtained by use of as many count-rate meters as required while limiting the number of telemetry channels needed to two is described. A circuit switches one telemetry channel from one rate meter to the next as the input rate changes, while the other telemetry channel is used to monitor which rate meter is being read out. A detailed circuit description and design considerations are given along with operating characteristics and an in-flight data sample. (auth)

13738 (UCRL-13106) RESEARCH AND DEVELOPMENT ON FABRICATION OF PIN AND LID DETECTORS AND THE DRY RUN INTERFACE SYSTEM. Final Report. F. P. Ziemba (Solid State Radiations, Inc., Los Angeles). Aug. 31, 1963. For California. Univ., Livermore. Lawrence Radiation Lab. Contract [W-7405-eng-48]. 86p. Dep.; $3.00(OTS).

The design, fabrication, and performance of two types of semiconductor detectors suitable for field use are presented. The first type is based on the lithium ion drift technique having a sensitive depth between 1 mm and 1 cm and active areas between 0.04 and 1.0 cm^2. The second type is the PIN detector having a sensitive depth of 250 μ and an active area between 0.04 and 1.0 cm^2. Detectors fabricated using the LID approach are designed primarily for high sensitivity, and the detectors fabricated using the PIN structure are designed primarily for speed. The performance of the detectors for high intensity gamma radiation and the dry run apparatus that was designed for the testing of the static and dynamic characteristics of these detectors under field conditions are described. (C.E.S.)

13739 (UCRL-Trans-1171) SOME PROBLEMS REGARDING THE MECHANISM OF A GAS DISCHARGE IN A SPARK CHAMBER WITH LARGE GAP BETWEEN ELECTRODES. V. A. Lyubimov, Yu. V. Galaktionov, F. A. Pavlovskii, F. A. Ech, and I. V. Sidorov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii. Institut Teoreticheskoi i Eksperimental'noi Fiziki, Moscow). Translated by S. Shewchuck (Univ. of California, Lawrence Radiation Lab., Berkeley), from Preprint No. 269. July 1964. 49p. Dep.(mn); $2.00(cy), 1(mn) OTS; $4.60(fs), $1.67(mf) JCL.

The mechanism of a gaseous discharge in a spark chamber with large gap is considered. In the light of the proposed model the following experimentally observed phenomena were explained: the dependence of spark track luminosity on the particle ionizing power, the lifetime of a spark chamber filled with inert gas, and the registration of particles produced in the gas of the spark chamber. In a series of cases a quantitative comparison of the experimental data was made with the theory. (auth)

13740 A NEW DEVICE FOR THE EVALUATION OF THERMOLUMINESCENT DOSIMETERS AND ITS APPLICATION IN γ-RADIATION DOSIMETRY. J. Felszerfalvi and J. Patko (Lajos Kossuth Univ., Debrecen, Hungary). Acta Univ. Debrecen. Ludovico Kossuth Nom., Ser. Phys. Chim., 9: 5-16(1963).

For uses in radiotherapeutical dosimetry, a very small-size thermoluminescent dosimeter was devised, composed of $CaSO_3$: Mn crystals. Evaluation equipment was constructed employing the existing nuclear instrument range. According to measurements, the intensity of the emitted thermoluminescent light was proportional over a wide range, between 10 and 1500 rads, to the absorbed dose. In addition, parameters of the micro-crystals devised were determined: the level depth of the grip-in activator (ΔE = 0.7 ev) and the frequency factor ($s = 5 \times 10^9$ sec^{-1}). Advantages of the dosimeters are their low production cost, theoretically unlimited life time, and small size. (auth)

13741 CALORIMETRIC DOSE RATE MEASUREMENTS IN THE CORE OF THE ASTRA REACTOR. E. Proksch and H. Bildstein (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Vienna). Atomkernenergie, 9: 431-6 (Nov.-Dec. 1964). (In German)

When irradiating organic liquids in the core of the ASTRA reactor the absorbed radiation doses are calculated from calorimetric data via the use of nickel flux monitors. The dose per unit integrated fast flux is considered to be constant as long as the irradiation position remains unchanged and identical with the position of calorimetric measurements. The calorimetric method used is a simple quasi-adiabatic one similar to the cross-over method. The temperature rise of an air-gap insulated calorimetric probe is recorded; the initial rise is identical with the adiabatic temperature rise provided that the calorimeter was at thermal equilibrium initially. Using a logarithmic extrapolation method for the determination of this initial rise an accuracy may be obtained which is comparable to that obtained by a true adiabatic method. The use of different probes (aluminum, carbon, polystyrene, and polyethylene) makes it possible to break down the measured total doses into the fractions due to the absorption of γ rays and the slowing-down of fast neutrons. (auth)

13742 EFFECT OF TEMPERATURE ON THE BACKGROUND OF HALOGEN-QUENCHED G-M COUNTERS. J. Lesinski (Inst. of Nuclear Research, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Tech., 12: 523-7(1964).

The performance of a G-M counter utilizing neon, bromine, and argon filling was evaluated for temperatures of 250 to 500°K. "Glow curves" are shown for varied exoemission conditions. (R.E.U.)

13743 ON NUCLEAR RADIATION AND RADIATION MEASURING APPARATUS. K. Bartneck. Bull. Schweiz. Elektrotech. Ver., 54: 468-77(1963). (In German)

The essential questions on nuclear radiation and the principal devices used to measure it are summarized. (tr-auth)

13744 RECENT DEVELOPMENTS IN Li-DRIFTED DETECTORS. I. L. Fowler (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Nucl. Technol., 4: 40-4 (1965).

A review is presented of Canadian efforts in the fabrication and further development of lithium-drifted p-i-n semiconductor detectors for spectrometer use. Emphasis is on gamma spectroscopy. (R.E.U.)

13745 IMAGE FUNCTION FOR ONE-CRYSTAL SCINTILLATION γ-RAY SPECTROMETER. J. Kajfosz and J. Urbanec (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 15: 17-29 (1965).

An analytical expression is derived for the image-forming process that occurs at the absorption of the energy of primary gamma rays in one-crystal scintillation spectrometers with cylindrical crystals. (D.C.W.)

13746 NEW PARTICLE DETECTORS. PART I. Gyoergy Somogyi (Lajos Kossuth Univ., Debrecen, Hungary). Fiz. Szemle, 14: 302-6(Oct. 1964). (In Hungarian)

Efforts are continuing all over the world to develop instruments with sufficiently high sensitivity to detect a single particle. In principle, a perfect method should yield information on the type and the energy of the particles in question, allowing to determine their interaction. In view of the great variety of particles and energy ranges that must be determined, a large number of detecting systems had to be developed. To clarify the problem definitions are given, dividing the particle detectors into 4 basic groups, counters, telescopes, hodoscopes, and track detectors. Until recently, the nuclear emulsion, the cloud chamber, the scintillation counter, and the discharge counter represented the available systems. The newly developed methods include the AgCl track detectors; these single crystals are developed by a photoelectric technique rather than by the usual chemical method. They do not detect the light particles but indicate the track of heavy particles without distortion and were used with good success in instruments carried by satellites. Another new type is the cryotron which is based on the fact its component wire is superconducting at very low temperatures but becomes nonsuperconducting in a sufficiently strong magnetic field. (Review article, 10 references). (TTT)

13747 NEW PARTICLE DETECTORS. PART II. Somogyi Gyoergy. Fiz. Szemle, 14: 351-7(Nov. 1964). (In Hungarian)

Among the recently developed detector types, the spark chamber presents the greatest interest because it can be built inexpensively and it operates reliably. It is similar to the GM tubes but by a suitable change in the geometry, the generation of the pulse after the appearance of a particle requires a time period of the order of a nanosecond; this is about 1000 times shorter than the corresponding time of the GM counters. At present there are about 60 research teams all over the world which are actively engaged in the application of spark chambers to specific problems in the field of high-energy physics. The particle or the event caused by it is observed by a coincidence or anticoincidence type telescope. The event is detected by the formation of an electron avalanche between the plates, resulting in a spark discharge. The instrument may be used for the examination of the polarization of high-energy scattering phenomena and the study of rare decay events and of short lifetime particles. Without it, it would have been impossible to study $K^- - \pi$, $\pi - p$, $\pi - \pi$ interactions or to demonstrate the existence of the two types of neutrino. To illustrate the system, the examination of the Λ^0 decay is described. Further development will probably be directed toward the reduction of the delay time, achievement of the 10^{-7} sec time resolution and the development of small chambers, aimed at the improvement of the spatial resolution. (Review article). (TTT)

13748 ON THE POSSIBILITY OF MEASURING THE QUALITY FACTOR OF NUCLEAR RADIATION BY MEANS OF IONIZATION CHAMBERS FILLED WITH LIQUID DIELECTRIC. Daniel Blanc, Jacques Mathieu, Paul Vermande, and Liberto Torres (Centre de Physique Nucléaire, Faculté des Sciences, Toulouse). Health Phys., 11: 63-5(Jan. 1965). (In French)

The counting characteristics of an ionization chamber filled with liquid hexane were systematically studied. The ionization current was determined as a function of the applied voltage between the electrodes for different particle fluxes and for various values of the distance between the plateaus of the ionization chamber. The current has the form $I = KV + f(V)$, regardless of the incident particle, where K depends on the flux and nature of the radiation, $f(V)$ is a function of the voltage V that becomes constant above a given value of V. All the slopes traced are characteristic of the nature and the energy of the incident particle. (J.S.R.)

13749 THE DEVELOPMENT OF A NANOSECOND TIME-OF-FLIGHT DETECTOR. Ming-dou Tang, Wo-yen Lee, and Chiu-an Chung (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 39-54(Feb. 1964).

A neutron time-of-flight spectrometer with a time resolution of about 1 nsec for a prompt coincidence curve recorded with a source of ^{60}Co is described. The energy resolution is around 3 to 10% from 1 to 14 Mev over a flight path of one meter. (D.C.W.)

13750 INTRODUCTION OF PROTON RECOIL TYPE FAST NEUTRON DETECTOR AND ITS CONSTRUCTION (TISSUE DOSE RATE MEASUREMENT TYPE). Lien-sheng Chuan and Tsong-jen Lee (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 55-64(Feb. 1964).

A proton-recoil neutron detector is described, which can be used directly as a neutron tissue dose meter after calibration against a Pu–Be neutron source and monoenergetic fast neutrons from the $D(d,n)^3He$ reaction. (D.C.W.)

13751 THE LIQUID HYDROGEN TARGET IN A HEAVY LIQUID CHAMBER. Paul Musset and Paul Queru (Centre National de la Recherche Scientifique, Paris). Ind. At., 8: No. 11, 67-77(1964). (In French)

The introduction of a liquid hydrogen target into a heavy liquid buble chamber combines some of the advantages of the hydrogen bubble chamber (interaction on free protons) with those of the heavy liquid bubble chamber (detection and measurement of neutral particles). The two targets, developed by collaboration between the High Energy Corpuscular Laboratory at Saclay and the Physics Laboratory of the Ecole polytechnique at Paris, are described. Conceived for experiments with 8 and 16 Bev/c π^-, they were used by CERN in the 1-m bubble chamber at the Ecole polytechnique, in the course of two experiments during which 350,000 photographs were taken. (tr-auth)

13752 INDIVIDUAL DOSIMETRY BY THERMOLUMINESCENCE. Michel Lorthioir (Universite, Brussels). Ind. At., 8: No. 11, 113-16(1964). (In French)

The thermoluminescence dosimeter MBLE type PNP-080 makes it possible to measure in several seconds the dose of gamma radiation (from 80 kev to more than 3 Mev) and slow neutrons (from several megarems to several thousand rem). The principles, construction, and performance of this dosimeter are described. (J.S.R.)

13753 A NEW DETECTOR FOR RADIOACTIVE AEROSOLS, TRANSISTORIZED AND WITH ELECTROSTATIC PRECIPITATION. Robert Richard-Foy (A.O.I.P., Paris). Ind. At., 8: No. 11, 117-21(1964). (In French)

The characteristics of a detector for radioactive aerosols are tabulated, and its performance is described. There is partial compensation of the natural radioactivity. The general electronic circuits are graphed. (J.S.R.)

13754 ABSOLUTE STANDARDIZATION WITH A NaI(Tl) CRYSTAL. IV. DETERMINATION OF THE PHOTOELECTRIC EFFICIENCY. G. A. Brinkman, A. H. W. Aten, Jr., and J. Th. Veenboer (Inst. for Nuclear Physics Research Amsterdam). Intern. J. Appl. Radiation Isotopes, 16: 15-18(Jan. 1965).

The absolute standardization of radioisotopes emitting two γ rays in coincidence (e.g., ^{46}Sc, ^{60}Co, and ^{24}Na) is possible with a NaI(Tl) well-type crystal by measuring the count rates under the photopeaks and the sumpeak. It is advantageous to measure the sumpeak with the sample in a position different from that used for the single photopeaks. The method was tested with ^{60}Co. (auth)

13755 A γ-γ COINCIDENCE COUNTER WITH ENERGY ANALYSIS OF THE COINCIDENT RADIATION. V. P. Burmistrov, A. Kh. Abil'daev, and V. A. Shilin. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 60-6(Jan.-Apr. 1964). (In Russian)

Two NaI(Tl) crystals (20×20 mm^2 in size) equipped with photomultipliers were used in a fast-slow coincidence counter. The pulses from one counter were analyzed for energy, and the pulses from the other counter were used as control pulses to determine coincidence. A circuit diagram for a fast coincidence scheme is also given. The re-

solving time can be varied from 0.04 to 0.1 μsec. A multichannel analyzer could be used to set the discriminator precisely by the use of a cathode follower and a switch. The counting efficiency was determined by means of a ^{60}Co source of known activity. True coincident pulses are counted at different efficiencies varying from 0 to 100% depending on the ratio of the coincident pulse amplitudes. With a resolving time of 0.04 μsec, the coincident count rate is about 100% from 300 to 1200 kev. The dynamic range is 1200/300 = 4. The dynamic range increases to 6 with an amplitude of 20 v in the control circuit and 40 v in the analyzing circuit. The dynamic range is at least 12 with a resolving time of 0.1 μsec. Coincident spectra are shown for ^{60}Co, ^{134}Cs, and ^{65}Zn. (TTT)

13756 INVESTIGATION OF HIGH-ENERGY NUCLEAR REACTIONS BY MEANS OF EMULSION CHAMBER COMBINED WITH WILSON CHAMBER. Zh. S. Takivaev and G. I. Turov. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 67-72(Jan.-Apr. 1964). (In Russian)

An emulsion pile was mounted in a fixed position between two Wilson cloud chambers. Photographs of cosmic particle traces and of secondary particles observed in the Wilson cloud chambers were used in order to determine the point of origin of the shower particles in the emulsion. The equipment was operated at 3340 m above sea level. The average number of charged particles per shower was 3.7 ± 0.3 (a value of n = 3.0 corresponds to an average of 10 Bev for the primary particle). A total of 27 stereo pictures out of 1600 were selected for analysis. It was found that not all traces observed in the Wilson cloud chamber belong to a definite nuclear reaction and that not all the particles from a nuclear reaction enter the Wilson cloud chamber. In spite of the amount of work involved, it would be desirable to use this method with large Wilson cloud chambers in the study of high-energy shower particles. (TTT)

13757 ANALYSIS OF CHARGED PARTICLE TRACK DISTORTION IN A WILSON CHAMBER. V. D. Saprykin. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 100-4(Jan.-Apr. 1964). (In Russian)

The identification of high-energy particles in a Wilson cloud chamber from measurements of the specific ionization and momentum has been extended from an energy region of 10^8 to 3×10^{10} ev. The size of the Wilson cloud chamber has increased from ~10 to >100 l, and it is necessary to find ways of decreasing the distortions in a Wilson cloud chamber to a minimum. These distortions are due to gas motion in the process of expansion, to convective motion because of heating of the adiabatically cooled gas by the chamber walls, and to local irregular movements. These errors can be almost eliminated by replacing the rubber diaphram with a metallic foil diaphram having a rubber border, and by proper thermostating of the Wilson cloud chamber. The construction of the chamber should assure regularity of the gas velocity at the moment of gas expansion. Large Wilson cloud chambers should have a temperature gradient of 0.5 to 0.6°C per 1 m of chamber height between the top and bottom in order to stabilize the gas in the cloud chamber. The film is held firm by vacuum in order to determine the trace coordinates accurately by steroscopic photography. (TTT)

13758 ON THE STATISTICAL NATURE OF BACKGROUNDS OF LOW BACKGROUND COUNTERS. Eiichi Tanaka and Takashi Maruyama (National Inst. of Radiological Sciences, Chiba-shi, Japan). J. Nucl. Sci. Technol. (Tokyo), 1: 339-42(Dec. 1964).

The statistical nature of the background counting rates of low background β-ray counting systems was studied. Chi-squared tests were applied to the background data obtained by several counting systems tested were four windowless G-M counters, five thin window G-M counters and one CO_2 proportional tube in conventional anti-coincidence shielding and one coincidence type β-ray scintillation spectrometer. The result shows that standard deviations of the background obtained with many of the anti-coincidence type G-M counters were considerably higher than expected from theory. (auth)

13759 ANALYSIS OF OUTPUTS FROM GAS FLOW COUNTER WITH RESPECT TO PLATEAU CURVES. Shuji Yamada and Munemaro Imai (Hitachi Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 343-9(Dec. 1964).

The plateau characteristics of proportional counters depend on the internal structure of the counters as well as on the specifications of the amplifiers used. Experiments were performed with gas flow counters to investigate such items as overload characteristics of the amplifiers, position of the center loop of the counter, and pulse height distribution. The results show that a plateau stretch of 600 v is obtained with gas flow counter using PR gas, and a stretch of 500 v with BF_3 proportional counter. It was determined from current-voltage curves that the maximum voltage of the proportional region was 2,600 v. (auth)

13760 VELOCITY OF PROPAGATION OF A DISCHARGE ALONG THE WIRE IN GEIGER-MUELLER COUNTERS WITH GLASS WALLS AND EXTERNAL CONDUCTING COATINGS. Vincent Bogui (Faculte des Sciences, Toulouse). J. Phys., Phys. Appl. (Paris), 25: 137A-40A(Nov. 1964). (In French)

The propagation of the discharge along the wire in a G-M tube was investigated using a tube with four equal graphite-coated sections (cathodes) separated by glass rings of equal width. The speed of propagation was determined as a function of electrode voltage by irradiating the graphite section on the end and measuring delayed coincidences between this section and the three other graphite sections. Measurements were made using fillings of pure methylal and of argon-methylal. (D.C.W.)

13761 ON VARIOUS MODES OF OPERATION OF SPARK COUNTERS OF THE (WIRE-PLANE) TYPE UTILIZED IN THE AIR. Jacques Maurel and Daniel Blanc (Faculte des Sciences, Toulouse). J. Phys., Phys. Appl. (Paris), 25: 141A-6A(Nov. 1964). (In French)

The minimum voltages for which streamers, sparks, the corona discharge, and the arc appear were measured as a function of the distance from the wire to the cathode. The thresholds for the arc and corona effect were studied in the absence of radiation, and the thresholds for sparks and streamers were studied under alpha particle irradiation. The critical value of the electric field for the corona effect was also investigated. Four different modes of operation were established. (D.C.W.)

13762 SEMI-AUTOMATIC APPARATUS FOR MEASUREMENT OF THE TRACK WIDTHS IN AN IONOGRAPHIC EMULSION. G. Baumann, H. Annoni, and H. Braun (Centre de Recherches Nucleaires, Strasbourg). J. Phys., Phys. Appl. (Paris), 25: 185A-8A(Nov. 1964). (In French)

An investigation is described of a photometric method for the determination of the charge of particles stopping in nuclear emulsions. The image of the track in the emulsion is projected by means of a microscope on a narrow slit placed in front of a photomultiplier and moved perpendicularly across the slit. The resolving power depends on the available track length; a satisfactory separation is possible for particles with a range of about 30μ. (auth)

13763 A SIMPLE METHOD OF PULSE HEIGHT TELEMETRY FOR A BALLOON-BORNE SCINTILLATION COUNTER. R. Kajikawa, F. Makino, M. Matsuoka, and Y. Tanaka (Nagoya Univ., Japan). Japan. J. Appl. Phys., 3: 724-7(Nov. 1964).

A simple method for telemetering the pulse height of a balloon-borne counter is described. The system consists of a photomultiplier attached to a scintillator, a logarithmic amplifier, a pulse-height-to-time converter and a radio transmitter. The apparatus is operated successfully for a temperature range from −30 to 30°C and for the pressure less than 10 mm Hg. (auth)

13764 DECAY TIMES OF NAPHTHALENE SCINTILLATORS. Shigeo Kobayashi (Tokyo Inst. of Tech.), Sohachiro Hayakawa, and Shozo Horikiri. Japan. J. Appl. Phys., 3: 798-9(Dec. 1964).

The decay times of naphthalene scintillators at 100°C

were measured with a sampling oscilloscope. Scintillation pulses produced by beta particles from ^{90}Sr were detected by a photomultiplier tube. The output signal was fed through a cable of characteristic impedance and was displayed on an oscilloscope. The observed decay times of various naphthalene scintillators were tabulated. (C.E.S.)

13765 GAMMA-RAY DETECTION SENSITIVITY OF NaI(Tl) CRYSTALS. A. Peil and J. Peil (Humboldt-Universität, Berlin and Martin-Luther-Universität, Halle-Wittenberg, Ger.). Kernenergie, 7: 762-6(Nov. 1964). (In German)

The gamma-ray total detection sensitivity of NaI(Tl) crystals relevant to activity measurements is calculated using Grosjean's approximation method. The basic formulae are presented, and the sensitivity of a crystal of 35 mm in diameter and 25 mm in length calculated as an example on the digital computer ZRA 1 is given for point, disk-shaped, and more general plane sources. The program allows for generalizing the calculations for other crystal dimensions, source sizes, and dimensions of the experimental arrangement. (auth)

13766 FOCUSING COLLIMATOR. Gyoergy Gyenge (MTA Orvosradiologiai Kutatocsoport, Budapest). Magy. Radiol., 16: 296-303(Oct. 1964). (In Hungarian)

An improvement in collimator design, for use with human radioisotope diagnostic studies, is described and illustrated. The various collimators currently in use are discussed in detail, with emphasis on their optimal fields of application and their drawbacks. Particular attention is given to collimators equipped with a number of openings rather than one opening. The best method is to arrange the holes like a honeycomb. The merits of various metals, such as lead, tungsten, and gold, for collimator construction are discussed. It was concluded that lead is the cheapest and easiest to mold, but the characteristics of the other two metals are more desirable. However, tungsten is difficult to mold and gold is too expensive, although it can easily be cast. The lead collimator produced and described has 7 openings, its depth or thickness is 80 mm, the focus is 160 mm from the crystal, the holes are 9 mm in dia at the posterior plate and 4.5 mm in dia at the face of the collimator. Distance between drilled holes on the rear side is 13 mm, wall thickness is 4 mm, the distance on the face is 6.5 mm and wall thickness is 2 mm. This particular model can be used for many types of examinations, but is somewhat crude and not very sensitive because a large surface of the crystal is shaded. Collimators with 19 and 40 holes were also made, but their construction was limited by the 60 × 60 mm crystal available, which was not considered to be the ideal size. The 40-hole collimator now under construction will utilize a 9 × 50 mm sodium iodide crystal, but the data as to distances and sizes is the same as the model with 7 holes. Illustrations are provided for the various units described. (BBB)

13767 A FOUR-DETECTOR ELECTRON DIRECTIONAL CORRELATION SPECTROMETER. P. Kleinheinz, L. Samuelsson, R. Vukanović, and K. Siegbahn (Uppsala Univ.). Nucl. Instr. Methods, 32: 1-27(Jan. 1965).

A high efficiency four-detector electron directional correlation spectrometer employing magnetic lenses is described. The instrument consists of three independent magnetic lenses and two NaI(Tl) γ detectors which can be combined in several ways for measuring directional correlations of electron-gamma and electron-electron cascades. Different detector geometries for correlation experiments and their symmetry properties are discussed. A new type magnetic lens electron spectrometer was designed which is suitable for application in a four-detector setup with fixed correlation geometry. The focusing properties of the electron spectrometer with envelope ring focus baffle are treated in detail and investigated experimentally by photographic ray tracing and by studying line profiles for different focusing parameters. The experimental line shapes show the characteristic asymmetry presumed for envelope momentum selection. Resolution-transmission characteristics were determined for a number of different source diameters. A more detailed resolution definition is required which takes into account the asymmetric momentum discrimination. The lenses are designed to have zero induction at the source position and made to have identical electron optical properties, essential in a four-detector setup. The residual imperfections which may influence the accuracy of the correlation result were experimentally determined and found to be very small. Design and performance of the scintillation detectors used for electron detection are described. (auth)

13768 A TAPE STORAGE SYSTEM FOR USE IN LOW COUNTING RATE MULTICHANNEL ANALYSIS. D. Segal, G. Ben-David, and U. Galil (Israel Atomic Energy Commission, Yavne). Nucl. Instr. Methods, 32: 28-30(Jan. 1965).

A tape system for storing pulse height information from low counting rate experiments is described. The events are recorded on the tape in digital form at a slow tape speed, and the information is later read into a conventional multichannel pulse height analyzer, using a speed-up factor of ten. With this technique a single multichannel analyzer can handle the data from as many as six independent low count rate experiments, at an additional cost of less than that of a second multichannel analyzer. (auth)

13769 IMPROVED SPECTRUM EXPANDER FOR SEMICONDUCTOR DETECTOR SPECTROSCOPY. M. Bertolaccini (Istituto Nazionale di Fisica Nucleare, Milan), C. Bussolati, and S. Cova. Nucl. Instr. Methods, 32: 31-6 (Jan. 1965).

An instrument is described by which semiconductor detector spectroscopy can be performed employing a conventional amplification chain and multichannel PHA with an increase by a factor of 10 or more in the number of available equivalent channels, as far as resolution capability is concerned. The method of compensation by charge injection in the detector is employed: a waveform is adopted which calculations show to allow linear compensation of the voltage pulse maximum at the input of the PHA without overload in the amplification chain. Circuit design ensures the stability required by high resolution spectroscopy, pulse pile-up rejection, and a dead time smaller than that of a conventional PHA. Experimental results confirm the expected performance. (auth)

13770 RECOVERY TIME AND COUNTING CHARACTERISTICS OF A G.M. COUNTER AT HIGHER INTENSITIES. J. H. Kramers (Atomenergikommissionen, Roskilde, Denmark). Nucl. Instr. Methods, 32: 37-44(Jan. 1965).

A qualitative explanation is given for the counting behavior of a Geiger-Mueller counter at higher intensities (10^4 c/sec). The calculations are based on simplifying assumptions about the dead time and recovery time. The results are compared in practice with a Philips 18507, a Mullard 9418, and a Philips 18506 counter. (auth)

13771 THE PULSE HEIGHT DEFECT IN SEMICONDUCTOR DETECTORS. R. C. Axtmann and D. Kedem (Soreq Research Establishment, Yavne, Israel). Nucl. Instr. Methods, 32: 70-7(Jan. 1965). (IA-983)

Measurements of the pulse height defect in a silicon surface barrier detector, with fission fragments whose energies were degraded in air, show that the defect is approximately constant in the fragment energy range 25–100 Mev. The results contradict an earlier hypothesis that the defect is caused by recombination of electron-hole pairs in the dense plasma produced by the fragment at the beginning of its track. A coincidence arrangement permitted separate studies of the median light and median heavy fragments. At increased fields in the detector, pulse height distributions of the respective fragment groups became distorted toward greater pulse heights. This result is interpreted to mean that, rather than decreasing recombination, the increased field causes charge multiplication in the counter. The onset of the multiplication appears to be a function of the ionization density in the fragment track. (auth)

13772 CONSTRUCTION AND PERFORMANCES OF SILICON LITHIUM DRIFTED DETECTORS. G. Bertolini,

F. Cappellani, and G. Restelli (EURATOM, Ispra, Italy). Nucl. Instr. Methods, 32: 86-92(Jan. 1965).

Some results obtained in the construction of silicon lithium-drifted detectors are presented. The applications to electron spectroscopy and performances of these detectors in the investigation of low-energy gamma-ray complex spectra are studied. (auth)

13773 A MAGNETIC LENS SPECTROMETER FOR ELECTRON-GAMMA AND ELECTRON-ELECTRON DIRECTIONAL CORRELATION MEASUREMENTS. W. L. Croft, B.-G. Pettersson, and J. H. Hamilton (Vanderbilt Univ., Nashville). Nucl. Instr. Methods, 32: 93-106(Jan. 1965).

A magnetic lens spectrometer was adapted for electron-gamma and electron-electron directional correlation measurements. One electron channel has magnetic momentum selection provided by a medium short magnetic lens spectrometer. The lens spectrometer is iron-free with the exception of two steel end plates which decouple the already weak magnetic field in the lens from the electron detector and from the movable gamma or electron detector. The source sits outside the magnetic field and is accessible through 180° to a movable detector. Directional correlation of electrons with gamma rays or electrons were carried out using a NaI(Tl) detector or an anthracene scintillation detector, respectively. A special source holder was designed for the electron-electron work. Electron energies down to 20 kev were measured in the lens. A proportional counter may be used to lower energies. The maximum lens energy is ≈5 Mev. The spectrometer mean emission angle was chosen to be 13.5°. The resolution can then be varied from 1 to 5% with a corresponding transmission of 0.4 to 1.5%. (auth)

13774 A SIMPLE INSTRUMENT FOR α-SPECTRUM ANALYSIS AT VARIOUS ANGLES. A. Seidman (Israel Atomic Energy Commission, Rehovoth, Israel). Nucl. Instr. Methods, 32: 107-8(Jan. 1965).

An instrument was developed to measure the energy spectrum at various angles of α particles emitted during fission and detected by a set of solid state detectors in a radial arrangement around the fissile target. (auth)

13775 A FAST PULSE HEIGHT DISCRIMINATOR. H. Jung, M. Bruellmann, and D. Meier (Eidgenössische Technische Hochschule, Zurich). Nucl. Instr. Methods, 32: 109-15(Jan. 1965). (In German)

A fast pulse-height discriminator was developed in conjunction with neutron measurements time-of-flight using a time-to-pulse-height converter. It discriminates between a discrete pulse-height spectrum and an intensive background of small pulses without introducing appreciable time jitter. The instrument can be fed with very short signals and thereby enables the time constant of the detector to be reduced to only a few nanoseconds. Input pulses exceeding an adjustable bias are stretched, appropriately preserving the original pulse front, and transmitted to the output in such a way that the delay becomes practically independent of their heights. The difference in delay Δt of the output pulses with respect to the input of the discriminator is <350 psec for signals exceeding the bias by $\Delta V \geq 0.5$ v. When $\Delta V \geq 3$ v, Δt reduces to <50 psec. The instrument can be operated at around 10^8 output pulses per second. (auth)

13776 AUTOMATIC MEASUREMENT AND DEMAGNETIZATION FOR THE SIEGBAHN-SLATIS BETA SPECTROMETER. F. May (Osterreichische Studiengesellschaft fur Atomenergie, GmbH, Vienna). Nucl. Instr. Methods, 32: 116-20(Jan. 1965). (In German)

An automatic control system is described for the Siegbahn-Slätis β spectrometer built in the electronics division of the Reactorcenter Seibersdorf. This system is similar to that described by Konopasek and Connor. But in addition to a control system for automatic measurements, a system for automatic demagnetization is included. The simple stepping device is described. The system operated since 1962 without significant difficulty. (auth)

13777 A HYBRID PREAMPLIFIER FOR COOLED LITHIUM ION-DRIFTED SEMICONDUCTOR DETECTORS. T. W. Nybakken and V. Vali (Boeing Scientific Research Labs., Seattle). Nucl. Instr. Methods, 32: 121-4(Jan. 1965).

The use of a cooled field-effect transistor as the input stage of a preamplifier for lithium-ion-drifted semiconductor detectors is discussed. A resolution of 0.98 kev fwhm Si was measured for zero external capacitance. As an example, the preamplifier was connected to a cooled detector, and a pulse-height analyzer spectrum was taken of the 6.5 kev x ray and 14.4 kev gamma ray of ^{57}Fe. (auth)

13778 A HIGH LUMINOSITY COMPTON SPECTROMETER. G. Bosi (Rome Univ.). Nucl. Instr. Methods, 32: 128-32(Jan. 1965).

The Compton spectrometer designed by Lee-Whiting is discussed. Disadvantages associated with using a curved radiator are emphasized. Those disadvantages may be removed, provided that anastigmatic focusing at the detector slit is given up. A Compton spectrometer is proposed with optimum luminosity almost twice as great as in Lee-Whiting's instrument. A drawing of suitable pole pieces is given: it is based on an analytical method proposed by Gersch. (auth)

13779 A SINGLE VALUED TIME TO PULSE HEIGHT CONVERTER USING TUNNEL DIODES. H. Weisberg (Brandeis Univ., Waltham, Mass.). Nucl. Instr. Methods, 32: 133-7(Jan. 1965).

A time to pulse height converter is described which has a single valued pulse-height vs time characteristic, rather than the usual double valued one. A narrow, delayed spike from the start channel is summed with a wide pulse from the stop channel and applied to a tunnel diode used as a switch. The switching characteristic of the tunnel diode automatically provides the desired pulse-height vs time characteristic, without the need for auxiliary circuits. Circuit details and results are given. Singles feedthrough is discussed. (auth)

13780 A PILE-UP ELIMINATION CIRCUIT. H. Weisberg (Brandeis Univ., Waltham, Mass.). Nucl. Instr. Methods, 32: 138-40(Jan. 1965).

The general principles of pile-up elimination are discussed. A new type of pile-up detector, consisting of a discriminator, an integrator, and a second discriminator, is described. A detailed circuit is presented along with results obtained using the circuit in a multichannel delayed coincidence system. (auth)

13781 A SIMPLE TIME-TO-PULSE HEIGHT CONVERTER FOR STOP-SIGNAL FREQUENCIES OF 3-40 MHz. W. Schweimer (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instr. Methods, 32: 190-6(Feb. 1965). (In German)

A simple time-to-pulse-height converter working with tunnel diodes is described. The equipment is especially well suited for measuring the time of flight of neutrons generated in a cyclotron. The starting signals used are the plate current pulses of a 56 AVP or a similar photomultiplier. A sine wave decoupled at the power oscillator of the cyclotron generates the stopping pulses. The frequency of the sine wave may be 3 up to 40 Mc. The linear range of the converter is shorter by 7 ns than the period of the sine wave. With the Karlsruhe isochronous cyclotron a line width of the prompt gamma radiation of 1.6 ns was measured. (auth)

13782 SCINTILLATION SPECTROMETRIC COUNTER TYPE D-20. Waldemar Lisieski and Waldemar Scharf. Nukleonika, 9: 835-7(1964). (In Polish)

A production model scintillation counter, the first of a series, was developed for use with a type WI-I (Eureka) amplifier and either a type ZWN4/2 (Eureka) or type ZWN-2800/4 (INCO) preamplifier. It employs a magnetically shielded Zeiss M12FS35(S12FS35) photomultiplier that is optically connected to a Teslu SKG-IS-33 × 25 NaI(Tl) scintillator. Other scintillators can be used, such as a –33 × 25 NaI(Tl), type SPD-22 plastic scintillator for

beta measurement or type SAD-12 ZnS(Ag) scintillator for alpha measurement. The power requirements and output characteristics are given, including a 9–11% resolution capability for 661-kev gammas from Cs-137. (TTT)

13783 COMPARISON OF SOME TYPES OF PHOTOMULTIPLIERS WORKING IN DC CIRCUIT. Roman Emmerich and Tadeush Florkowski. Nukleonika, 9: 885-90 (1964). (In Russian)

The performance of three photomultiplier models (American, Russian, and German) was analyzed. They are used together with scintillation counters for measuring the intensity of beta or gamma radiation. In order to evaluate their stability ranges, both static and dynamic, their operation in a current averaging circuit was compared. The photomultiplier in such arrangement feeds a parallel DC-circuit the voltage across which is a direct measure of radiation impinging on the counter-photomultiplier system. It was found that only a dynamic test provides the criterium of suitability. On this basis the German model was found to be well qualified to compete with the American model, while the Russian model cannot be used in systems where the radiation dose is subject to wide dynamic fluctuations. (ATD)

13784 METHODICAL INVESTIGATION OF GEL SCINTILLATORS AND THEIR APPLICATIONS. Hans Spenke. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 10, 192-7(1963). (In German)

The suitability of Al stearate gel and Aero-Sil gel (a trade name for SiO_2 of very small particle size) as gelling agents for scintillators was investigated. The studies showed that the Al stearate gel was superior to the Aero-Sil gel with respect to sample constancy, homogeneity, and complete uptake of the activity in the scintillator. The use of the Al stearate gel scintillator in β spectroscopy, absolute β activity determination, and half-life measurements of ^{204}Tl was studied, and the results showed that in all three cases satisfactory agreement with the values reported in the literature was obtained. (J.S.R.)

13785 FILM DOSIMETRY OF HIGH-ROENTGEN AND GAMMA RADIATION DOSES. J. Benes and J. Kopec (Tschechoslowakischen Akademie der Wissenschaften, Prague). Phot. Korr., 100: 93-9(1964). (In German)

Methodical studies were carried out to determine utilization possibilities of the photographic method for measurement of high doses of x and gamma radiation. The direct-darkening method, which is suitable under the simplest conditions for the measurement of doses over 10^4 r, can be carried out in each laboratory. It is simple and fast and can be done with commercial types of x-ray film. The evaluation can be made with a commercial densitometer whose accuracy also determines the accuracy of this method. By application of the perturbation of the latent image, the upper limits for dose measurement can be shifted. The density of the blackening of the correspondingly treated material is proportional for a given initial range of the radiation dose. The error of the method depends on preservation of standard conditions in preparation. (tr-auth)

13786 A CENTER OF NEUTRON-SPECTROMETRIC MEASUREMENTS. G. P. Zhukov, B. E. Zhuravlev, G. I. Zabiyakin, and V. N. Zamrii (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 6, 34-8(Nov.-Dec. 1964). (In Russian)

The design and construction of a center for spectrometric studies at the Joint Inst. for Nuclear Research is described. The center was designed to operate with a fast pulsed reactor and multichannel recording instruments. The obtained data are developed by separate sections and channeled to the central computing machine. (tr-auth)

13787 CHARACTERISTICS OF SPARK CHAMBERS FILLED WITH VARIOUS GAS MIXTURES. E. A. Damaskinskii, S. K. Demidov, and N. I. Rynnov (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 6, 45-50(Nov.-Dec. 1964). (In Russian)

The influence of gas composition on the irregularity of spark-glow intensity at different discharge intervals, in spark detectors along cosmic particle tracks was investigated. The effect of gas impurities on the number of spurious discharges associated with the proper discharge along the particle paths was also investigated. The minimum energy necessary to induce glowing discharges at certain spark intervals was found. It is suggested that an argon-acetylene mixture is as effective in spark chambers as a Ne–Ar mixture. (tr-auth)

13788 CONTROL AND SUPPLY SYSTEM OF SPARK CHAMBERS FOR RECORDING CHARGED PARTICLE SHOWERS. V. N. Bolotov and M. I. Devishev (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 6, 53-5(Nov.-Dec. 1964). (In Russian)

A control and supply system for recording separate particles passing through a spark chamber is described. The system is capable of feeding high-voltage pulses, simultaneously, into several spark chambers with large operational areas. (tr-auth)

13789 INVERSE γ-RAY SCATTERING IN SCINTILLATION DETECTORS. S. A. Baldin. Pribory i Tekhn. Eksperim., No. 6, 56-60(Nov.-Dec. 1964). (In Russian)

Gamma backscattering was studied as a function of the density, thickness, and type of scattering materials. The effect of the dimensions of the scintillation counter shielding screen on backscattering and the means for reducing spectrum distortions from backscattering are analyzed. (tr-auth)

13790 DISPERSION DETECTORS FOR SLOW NEUTRONS. A. F. Vedekhin znd V. D. Kuchernyuk (Volga-Ural Branch of the All-Union Scientific Research Inst. of Geophysics, USSR). Pribory i Tekhn. Eksperim., No. 6, 65-7 (Nov.-Dec. 1964). (In Russian)

A large dispersion detector was developed by means of polymerization of methacrylic acid methyl ester in the presence of T–1 phosphor mixtures which are sensitive to slow neutrons. The scintillation counter characteristic curve depends on the dimensions of the detector, the amount of phosphors, and its granularity. (tr-auth)

13791 CYLINDRICAL DETECTORS FOR SLOW NEUTRONS. A. F. Vedekhin. Pribory i Tekhn. Eksperim., No. 6, 67-9(Nov.-Dec. 1964). (In Russian)

The dependence of the scintillator counter characteristics on the content of boric acid in the phosphor, the thickness of the neutron sensitive layer, and the grain size was investigated. It is shown that it is possible to increase the efficiency of the detector by increasing the thickness of the sensitive layer. (tr-auth)

13792 A DEVICE FOR DETERMINING RELATIVE BIOLOGICAL RADIATION EFFICIENCY. M. Zel'chinskii, V. N. Lebedev, and M. I. Salatskaya (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 6, 73-6(Nov.-Dec. 1964). (In Russian)

A device was developed for determining the radiation hazards in fields of mixed ionizing radiation. The instrument is capable of simultaneously measuring the absorbed doses and the relative biological efficiency. The device is based on a recombination method using a recombination column and tissue-equivalent gas mixtures. (R.V.J.)

13793 NANOSECOND MULTIPLE COINCIDENCE AND ANTICOINCIDENCE SCHEME IN TUNNEL DIODES AND TRANSISTORS. A. F. Dunaitsev (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 6, 77-82(Nov.-Dec. 1964). (In Russian)

Descriptions are given of multiple coincidence and anticoincidences on tunnel diodes, diodes, and transistors. The resolving time measured with a beam of mesons was ~2 nsec. The anticoincidence efficiency is ~0.9997 (tr-auth)

13794 CONTROL SYSTEM FOR A DEVICE USED FOR STUDYING NUCLEAR MAGNETIC RESONANCE BY SPIN

ECHO METHOD. S. I. Borovitskii, M. N. Starodumov, and V. I. Tiflov. Pribory i Tekhn. Eksperim., No. 6, 89-93 (Nov.-Dec. 1964). (In Russian)

The design of a device for spin echo observations is described. The performance characteristics of the device are also presented. (R.V.J.)

13795 PRACTICAL POSSIBILITIES AND APPLICATIONS OF THE NUKAB SCANNER WITH MAGNETIC MEMORY. G. Fava and L. Roncoroni (Universita, Milan). Radiol. Med., 50: 1264-76(Dec. 1964). (In Italian)

A new apparatus for studying the distribution of radioactive substances introduced into the body is described. Besides the normal scintigraphic examinations, the apparatus permits, simultaneously with the former, registration of the local activity on graph paper and magnetic tape. The activity recorded on magnetic tape can be further elaborated according to the requirements of the examination, and reproduced on Polaroid film. The apparatus also permits total scanning of the body and one-dimensional recording (body profile) for studying the secondary localizations of cancer of the thyroid. (auth)

13796 RESULTS OF A FILM-BADGE RELIABILITY STUDY. Robert O. Gorson, N. Suntharalingam, and John W. Thomas (Univ. of Pennsylvania, Philadelphia). Radiology, 84: 333-46(Feb. 1965).

Twelve commercial film badge suppliers and two national laboratories were included in an intercomparison study of the accuracy and consistency of film-badge readings involving over 800 badges exposed in March 1963. Twenty-eight exposures ranging from 16 to 8200 mR were used. Badges were exposed to gamma rays of cobalt-60 and radium-226 and to x rays in the hvl range of 1.4 mm Al to 3.3 mm Cu. Badges from most suppliers were exposed in duplicate. Duplicate sets were ordered through co-operating institutions and were returned for processing three days after the first set. Comparison of the reported values for duplicate exposures was considered a measure of the consistency of the evaluation procedure. Companies were not informed that a test had been conducted until after all the reports had been received. Results showed a considerable range in both accuracy and consistency among the 12 companies tested. The percentage of the reported values in error by more than ±50 per cent ranged from 7 to 50. The percentage of duplicate exposure readings differing by a factor of 1.5 or more ranged from 0 to 75. Most companies were considerably more successful in evaluating exposures to cobalt 60 and radium 226 than they were in reporting the exposures to x rays or to mixed x and gamma radiations. The reports of several companies were comparable in accuracy to the two national laboratories. (auth)

13797 THE EFFICIENCY OF RADIOGRAPHIC TUBES. Frank E. Maddison and Earl R. Miller (Univ. of California, San Francisco). Radiology, 84: 347-50(Feb. 1965).

Inherent filtration of a series of x-ray tubes was found to vary from 0.4 to 0.8 mm Al equivalent. While this does not affect clinical use, it must be taken into account when one is making absorption measurements of quality. Measured kilovoltage on a group of machines at the same kilovolt settings showed wide variation. The reasons for this are discussed. Efficiency of x-ray machine output appears to be dependent primarily on the tube insert, other things being equal. Compensation for changes in efficiency should be made by changes in time and/or tube current, and not on adjustment of transformer settings of kilovoltage. (auth)

13798 PROPERTIES OF WIDE-GAP SPARK CHAMBERS. J. P. Garron, D. Grossman, and K. Strauch (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instr., 36: 264-70(Mar. 1965).

The operation of spark chambers with gaps of up to 40 cm was studied. By applying electric fields of the order of 10 kv/cm, particle spark tracks suitable for accurate curvature measurements were obtained. The uniformity of the electric field represents a very important factor in determining the limit of accuracy of curvature measurements. By comparing two 40-cm chambers located in a magnetic field against each other, it is found that the momentum of a 1-Bev/c cosmic ray can be measured to an accuracy of ±1.4% with one 40-cm chamber located in a 13.3 kgauss magnetic field. Sensitive times of 5 μsec are typical. (auth)

13799 USE OF A LARGE GAP SPARK CHAMBER IN AN INTENSE BEAM OF PARTICLES. T. M. Knasel, J. K. Walker, and M. Wong (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instr., 36: 270-1(Mar. 1965).

An application is considered in which a beam of charged particles is passed through a large-gap spark chamber. It is shown that the use of helium gas contained in a thin plastic bag in the region of the beam can reduce the efficiency of the spark chamber, in that region, to as little as 10^{-6} or less. The efficiency for track detection outside this region is maintained at 100% with the use of a gas mixture of 89% neon, 10% helium, and 1% argon. (auth)

13800 ON THE DETERMINATION OF SATURATION CURRENTS OF HIGH-PRESSURE CHAMBERS. Erich Tschirf (Atominstitut der Österreichische Hochschule, Beschleunigerabteilung, Vienna). Strahlentherapie, 126: 145-50(Jan. 1965). (In German)

It is shown that compensation methods for the determination of the saturation current of parallel plate chambers can be also applied to cylindrical chambers under certain conditions. Extrapolation methods are considered and compared with the calculation method. (auth)

13801 X-RAY ELEMENTS FOR DOSIMETRY. PART II. Harald F. H. Warrikhoff (Max Planck-Gesellschaft, Berlin). Z. Angew. Phys., 18: 89-95(Nov. 16, 1964). (In German)

The general research structure and the x-ray elements and dosimeter used were described. The results of the experiments carried out showed a satisfactory agreement with the values calculated in Part I. The vacuum must be better than 1×10^{-3} torr. The optimum electrode thickness corresponded (as in the counter tube) to the maximum range of the electrons emitted. The sensitivity increased uniformly with the size of the difference of the atomic number of the electrodes used, whereas the wave length dependence decreased. With the optimum construction, a sensitivity of 1.3 v/R with ^{60}Co or 3.4 v/R with ^{137}Cs radiation was obtained with a Pb–C mantel element with an outside diameter of 20 mm. (tr-auth)

13802 X-RAY ELEMENTS FOR DOSIMETRY. PART III. Harald F. H. Warrikhoff (Max Planck-Gesellschaft, Berlin). Z. Angew. Phys., 18: 95-105(Nov. 16, 1964). (In German)

The operation of electrical radiation detectors was outlined, and it was shown that the air equivalent of the detector material represents no generally valid index for a dose-proportional measurement effect. Especially in detectors in which the number of the electrons released by the radiation, but not their energy, is used for the measurement, no air-equivalent material may find use. In place of the filtering of the primary radiation often used for the reduction of the wave length dependence, the electron emission caused by the x and gamma radiation on the electrodes was so decreased or amplified in dependence on the hardness of the primary radiation that a practical dose-proportional measurement effect resulted. The application of this method to the x-ray elements in a cylindrical output with lead external electrodes (mantel element) and a graphite rod as internal electrode with electron filters of copper of 80 mg/cm^2 and a window for soft radiation in the range from 80 kev to 1.25 Mev led to a mean sensitivity of 0.48 v/R with a wave length dependence of only ±8%. (tr-auth)

13803 NUCLEAR SPECTROMETER APPLICATIONS. Wendell H. Bradley, Russell H. Huebner, and Fred H. Wichman. First Edition. Indianapolis, Nuclear Measurements Corporation, 1962. 227p. $10.00.

A manual on gamma detection and measurement, x-ray detection, and beta detection and spectrometry with a

gamma spectrometer is presented, illustrated with spectra from these applications. The performance of sliding pulse and conventional spectrometers is compared. Spectra from synthetic isotopes, naturally radioactive isotopes, environmental activity, and x-ray studies are included. (D.C.W.)

13804 PRIKLADNAYA SPEKTROMETRIYA IONIZIRUYUSHCHIKH IZLUCHENII. (Applied Spectrometry of Ionizing Radiation). E. L. Stolyarova. Moscow, Atomizdat, 1964. 424p.

A systematic review is made of the physical aspects of ionizing radiation spectrometry, spectrometric equipment, and scintillation methods. Aspects of spectrometric applications in the protection against γ radiation, measuring low-level activities and isotopic content of radioactive materials and in activation analysis are also surveyed. (R.V.J.)

13805 A LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETER. A. F. Holloway and E. M. Campbell (Manitoba Cancer Treatment and Research Foundation, Winnipeg, Can.). 9p. (CONF-640611-4)

From Canadian Assn. of Physicists, Division of Medical and Biological Physics, Annual Meeting, Halifax, Nova Scotia, Can.

A commercial LiF thermoluminescent dosimeter was investigated for use in the calibration of the betatron beam. The calibration of the dosimeter resulted in some low readings, and the calibration curves were different from that supplied by the manufacturer. Some of the possible reasons for the discrepancies are discussed. The dosimeter was then used to measure the absorbed dose in a phantom exposed to an electron beam at 10 to 35 Mev. The slight energy dependence which was observed did not exceed 6%. (D.L.C.)

13806 GAMMA DOSIMETRY IN A MIXED RADIATION FIELD ABOVE 10^6 ROENTGENS. L. D. Pye (Bausch and Lomb Inc., Rochester, N. Y.), J. R. Hensler, and A. W. Snyder. 16p. (CONF-617-13)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

Gamma radiation dosimetry from 10^6-10^{10} R is achieved by measuring a radiation-induced absorption band in a bismuth silicate glass. Linearity and stability have been demonstrated up to 10^{10} R and post-irradiation fading is reduced by a simple heat treatment. The glass shows good discrimination in a gamma-neutron field and the response is essentially the same for ^{60}Co, spent fuel elements, and reactor exposures. Special compositions were fabricated to minimize activation during reactor exposures. The response of these glasses to gamma irradiation was measured as well as the induced radioactivity per unit volume as a function of time following irradiation. (auth)

13807 IMPROVEMENTS IN AND RELATING TO DEVICES FOR THE DETECTION OF RADIOACTIVITY. Robert George Bryer (to R. A. Stephen & Co. Ltd.). British Patent 976,110. Nov. 25, 1964. Filed May 21, 1962.

A dosimeter locket that provides an adequate seal for the element and that can be readily and repeatedly opened for reading is described. The locket is composed of four parts: (1) the radiation-sensitive element, a dissociable phosphate material such as silver phosphate, contained in a block of glass, (2) the inner metal casing formed in two parts sealed together with an O-ring and containing the glass block, (3) an outer casing formed by molding two halves from a synthetic plastic material and closed by a threaded joint, and (4) a lead shield or disc between the inner and outer casings. The lead disc has perforations of suitable size to equalize the response of the radiation-sensitive element to different energy levels. In its preferred form the locket can be placed in its normally closed condition in a reader and then exposed for reading. (A.G.W.)

13808 PULSE CONVERTER CONTROL APPARATUS. Balthasar H. Pinckaers (to Honeywell Inc.). U. S. Patent 3,161,774. Dec. 15, 1964. Filed Jan. 30, 1961.

The control apparatus described is intended to provide a sensitive and accurate discrimination against the inherent background count of the Geiger tube. The apparatus includes a pulse converter that provides a constant output signal only in response to input signal pulses occurring at intervals less than a given time interval. The output of the apparatus is independent of the past frequency of signal pulses. (A.G.W.)

13809 NEUTRON FLUX DETECTOR. R. N. Cordy and J. W. Flora (to U. S. Atomic Energy Commission). U. S. Patent 3,163,759. Dec. 29, 1964.

A neutron flux detector is described, which has a resistance element formed from a fissionable alloy electrically connected to a suitable calibrating means. The resistance element, upon exposure to a neutron flux source, internally generates fission heat in a manner directly proportional to the neutron flux integral to provide a virtual zero thermal time constant, facilitating an accurate determination of the intensity of the neutron source by differentiating the resulting resistance time function. (AEC)

13810 LOW ENERGY BETA RADIATION SYSTEM FOR FLUENT MATERIALS WITH PLURAL SCINTILLATION FIBERS IN HEXAGONAL ARRAY. Clinton A. Stone, Leonard Reiffel, and Italo Filosofo (to U. S. Atomic Energy Commission). U. S. Patent 3,169,187. Feb. 9, 1965.

A radiation counter for measuring the radioactivity of a gas or a liquid sample is described. The counter comprises a cylindrical container having glass end walls and a plurality of like solid cylindrical scintillating fibers formed into a closely packed array essentially hexagonal in cross section and disposed longitudinally within the container. The ends of the fibers are optically coupled and sealed to the end walls of the container and means are provided for injecting the sample into the container between the interstices of the fibers along the length thereof. Means are also provided for detecting scintillations at the end walls of the container. These scintillations are a measure of the radioactivity of the sample. (AEC)

Radiation Effects

Refer also to abstracts 14868, 14871, and 14872.

13811 (AD-422354) EFFECTS OF NUCLEAR RADIATION ON FREQUENCY CONTROL DEVICES. Report No. 3. Third Quarterly Progress Report, March 1–May 31, 1963. B. Gerstein, A. Fueyo, and F. Trainor (Admiral Corp., Chicago). June 28, 1963. Contract DA 36-039 AMC-00002(E). 42p. (G3988-3-3). $4.60(OTS).

The final version of the phase detector for measuring of small transient phase angle changes in quartz crystal units exposed to simulated nuclear weapons environment is described. The present system has a resolution of better than 10:1 compared to the dot system used in previous studies. The final version of the oven temperature remote control system for the precision crystal unit ovens is also described. The stability of the system has been increased by the use of a differential amplifier in the bridge control circuit. A packaged crystal oscillator has been selected for evaluation as part of Task C. The special test fixture for interchangeable mounting of the precision and moderate crystal units as well as for the crystal oscillator units has been constructed. (auth)

13812 (FZK-184-3) NERVA COMPONENTS IRRADIATION PROGRAM. VOLUME 3. GTR TEST 13. E. E. Chappell, J. W. Evans, E. E. Palmer, L. P. Stuart, and W. D. McMillan (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Sept. 13, 1964. Contract AF29(601)-6213. 99p.

The tenth in the series of irradiation tests using the Ground Test Reactor at the Nuclear Aerospace Research Facility to determine the effects of reactor radiation on candidate NERVA engine components was concluded on 12 June 1964. The items in the test, designated GRT-13,

include strain gages, thermocouples, a control drum plate section, and piezoelectric ceramic discs. The results of the test are described. (auth)

13813 (WL-TDR-64-97) RADIATION EFFECTS PARAMETERS IN NAP APPLICATIONS. R. M. Magee (Bendix Corp. Bendix Systems Div., Ann Arbor, Mich.). Nov. 1964. Contract AF29(601)-5911. 186p.

The radiation effects caused by different neutron-energy spectra and neutron-to-gamma flux ratios were determined for several silicon transistors. Tests conducted on four planar transistor types (2N709, 2N914, 2N1711, and 2N2894) showed that neutron-to-gamma ratio effects are most significant at low radiation exposures. At these exposures, the damage from gamma radiation may be a significant fraction of the total radiation damage. At higher radiation exposures, neutron effects predominate, and the neutron-spectrum effects may be significant. Calculations of displacement-induced damage showed qualitative but not quantitative agreement with the results of reactor tests. It was also found that other parameters have important effects on the radiation damage observed. In particular, electrical measurement and operating conditions during irradiation can have at least as much effect as do neutron-spectrum or neutron-to-gamma ratio variations. (auth)

13814 ON THE THERMAL CONDUCTIVITY OF SINGLE CRYSTALS OF GERMANIUM IRRADIATED BY FAST NEUTRONS. H. J. Albany and M. Vandevyver (Centre d'Etudes Nucleaires, Saclay, France). J. Phys. (Paris), 25: 978-80 (Nov. 1964). (In French)

The thermal conductivity χ, between 80 and 300°K, of germanium single crystals irradiated at 70°C by fast neutrons is analyzed on the basis of the Callaway model. It is found that the χ decrease after irradiation can not be explained only by the increase of the $\tau^{-1} = A\omega^4$ scattering, relative to phonon scattering by point or "small" defects. An increase of the $\tau^{-1} = c/L$ scattering by the crystal boundary must be considered. The L decrease in comparison with the geometrical sizes of the single crystal, after neutron bombardment, is associated with the formation of defect clusters having sizes larger than phonon wavelengths. This diminution is found to increase with irradiation dose indicating that, up to 1.2×10^{18} n cm^{-2} the maximum integrated flux used, there is no cluster saturation. A comparison is made of these results with those previously obtained in silicon. (auth)

13815 FIELD-EFFECT TRANSISTOR EVALUATION FOR NUCLEAR AEROSPACE ENVIRONMENTS. F. L. Schmid and R. H. Derington (Bendix Corp., Southfield, Mich.). 21p. (CONF-617-11)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

Sample groups of field-effect transistors were tested under extreme gamma radiation (total dose of 10^8R) and temperature (−200 to +125°C) environments to determine the effects on zero bias current, transconductance, pinch-off voltage, drain and source leakage currents, and breakdown voltage. In the radiation tests, the transconductance, zero-bias current, and pinch-off voltage exhibited only limited change; leakage currents and breakdown voltages exhibited much larger changes. The temperature tests indicate that the field-effect transistor is superior to the conventional bipolar transistor for use over wide temperature ranges. Analysis of the results of various temperature tests, including those performed by other investigators, has led to the derivation of an equation which can be used to predict major design parameter changes with temperatures. (auth)

13816 RADIATION INDUCED SURFACE EFFECTS ON SELECTED SEMICONDUCTOR DEVICES. U. Cocca (General Electric Co., Syracuse, N. Y.) and N. B. Koepp-Baker. 39p. (CONF-641009-6)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

A preliminary investigation into the effects of space indigenous radiation on a number of semiconductor devices is described. A ^{60}Co source was used to irradiate the devices to an ionization level equivalent to that received by a satellite in a typical orbit in a six-month period. Transistor I_{CBO} and diode I_R were monitored throughout the irradiation and pre-test and post-test transistor gain measurements were made. The results of the irradiation test are presented in graphical and tabular form. In general, transistor and diode reverse current increased and transistor gain decreased during irradiation. Some recovery was evidenced following storage and temperature annealing cycles. (auth)

13817 RADIATION TOLERANCE OF SILICON DIODES. Waylon Bryan (Texas Instruments Inc., Dallas). 15p. (CONF-640910-2)

From International Convention on Military Electronics, Washington, D. C.

Empirical data and device designs are presented for radiation studies conducted on various diodes. The studies include a diode specifically designed for high radiation tolerance in the 200- to 400-volt range, a general purpose diode, and a computer diode. The effects of both neutron and electron radiation on all diode parameters are reported. Neutron studies were conducted only on the radiation tolerant diodes. Electron studies were conducted on all three types of diodes. The effects of 2 and 3 Mev electrons were studied between the levels of 5×10^{14} and 5×10^{16} evt. Neutron effects were studied at energies greater than 10 kev between the levels of 10^{13} and 5×10^{15} nvt. (auth)

13818 TRANSIENT RADIATION EFFECTS ON TRAVELING WAVE TUBES. R. A. Magnuson (General Electric Palo Alto Tube Operation, Calif.). 22p. (CONF-641009-1)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

A discussion is given of the transient radiation effects on traveling-wave tubes that were subjected to three series of tests at the Sandia Pulsed Reactor Facility. Topics included are (1) construction and theory of test tubes, (2) instrumentation of tests, (3) variation of tube parameters during tests, and (4) possible failure mechanisms. The tubes were found to be susceptible to pulsed radiation since the gain decreased by 3 to 10 db during the radiation bursts. (auth)

13819 NEUTRON AND NEUTRON SPECTRA CONTRIBUTION TO DAMAGE IN SILICON F.E.T.'S. Alvin B. Kaufman (Litton Systems, Inc., Woodland Hills, Calif.). 23p. (CONF-641009-2)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

A determination of the effect of neutron and neutron spectra on silicon field effect transistors (F.E.T.) allows the performance of such devices to be extrapolated from existing data, with reasonable accuracy, to a significantly different environment. The program which developed the technique and determined damage constants (for various neutron energy groups) also examined the effect of the gamma ray exposure. Six different nuclear facilities were used in the empirical phase of the program. Three of the reactors were steady state and three were pulse type. Each reactor produced a distinct spectrum and dose rate signature. Eight F.E.T.'s (five types and geometries) were exposed in each environment. The effect of geometry and doping were considered. (auth)

13820 NUCLEAR RADIATION EFFECTS ON Ge:Hg AND Ge:Cu IR PHOTOCONDUCTORS. George Martzin (LTV-Vought Aeronautics Div., Dallas), Don Brown, and John P. Walker, Jr. 28p. (CONF-617-14)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

This paper describes the results of a radiation effects testing program at NARF of ten long wave IR photoconductors, five Ge:Cu and five Ge:Hg. The objective of the test was that of determining gamma and neutron rate effects on

the production of noise in the IR photoconductors and determining the effect of total integrated dose on photoconductor performance. The results of these tests were as follows. First, the noise produced by gamma radiation is flat and becomes significant with respect to normal ambient background noise at gamma dose rates of 10-100 R/min and increases as the square root of the gamma dose rate thereafter. Second, noise produced by neutron rates of 10^8 neutrons/cm^2-sec is such that it is completely masked by gamma dose rates of 150 R/min. Third, the detectivity of all of the ten photoconductors declined by a factor of between 3 and 4 at integrated doses of 5×10^{14} neutrons/cm^2 (E > .3 Mev) for seven of the ten photoconductors and a factor of approximately 10 for the other three (but two of these three started out having poorer detectivity). Fourth, the most significant factor affecting the design of an IR system operating in the nuclear radiation environment is the large change in resistance of the photoconductor with integrated dose, and a correspondingly large change in photoconductor responsivity. (auth)

ISOTOPE TECHNOLOGY

General

13821 (CONF-641101) ISOTOPE SYSTEMS DEVELOPMENT PROGRAM. Sixth Annual Contractors Meeting, November 9 and 10, 1964. (Division of Isotopes Development, AEC). 76p. Dep.; $3.00(OTS).

Thirty-eight short presentations are included; no separate abstracts have been prepared. The topics studied include radioisotope technology, tracer techniques, instrumentation, activation analysis, data compilations, radioisotope uses in analytical chemistry, and radioisotope properties. (T.F.H.)

13822 (TID-3914) DIVISION OF ISOTOPES DEVELOPMENT AND CONTRACTOR PUBLICATIONS. (Division of Technical Information Extension, AEC). Nov. 1964. 31p. Dep.; $2.00(OTS).

References are presented to publications which are pertinent to radioisotope technology and radiation applications. These publications are arranged according to the issuing agencies, which include the Division of Isotopes Development and its contractors, AEC national laboratories, and other Government agencies. (D.L.C.)

13823 RESEARCH WITH THE ISOTOPES OF OXYGEN (O^{15}, O^{17}, AND O^{18}) DURING 1961-1963. J. L. Borowitz, D. Samuel, and F. Steckel (Weizmann Inst. of Science, Rehovoth, Israel). Intern. J. Appl. Radiation Isotopes, 16: 97-142(Feb. 1965).

References (607) on research with ^{15}O, ^{17}O, and ^{18}O are given to journals and reports published from 1957 through 1963. Separate author and subject indexes are included. (P.C.H.)

13824 ISOTOPES AND RADIATION TECHNOLOGY. Volume 2, Number 2. P. S. Baker, Robert H. Lafferty, Jr., Martha Gerrard, D. A. Fuccillo, and R. E. Greene, eds. (Oak Ridge National Lab., Tenn.). Winter 1964–1965. $0.55(GPO) (domestic), $0.70(GPO) (foreign). Dep. (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

Research progress on isotopes and radiation technology is reviewed. The following topics are considered: isotope production and development, isotope technology development, process radiation development, source development, medicine, and safety. Separate abstracts were prepared for 8 papers presented. (M.C.G.)

For abstracts of individual papers see: 12900, 13439, 13678, 13679, 13830, 13831, 13832, and 13848.

Industrial Applications

Refer also to abstracts 13009 and 13569.

13825 EFFECT OF GAMMA IRRADIATION ON THE COLIFORM BACTERIA IN RAW MILK. Mieczyslaw Dluzewski and Eugeniusz Pijanowski (Agricultural Univ., Warsaw). Acta Microbiol. Polon., 13: 233-46(1964).

A study was made of the possible use of ionizing radiation to selectively inactivate the majority of coliform bacteria in raw milk, and thus to make it more suitable for cheese production. In this way the pasteurization of milk could be avoided or at least attenuated, which would be beneficial to the physical and, possibly, organoleptic qualities of cheese. When fresh, unpasteurized milk was exposed to a ^{60}Co source, coliform bacteria were inactivated to a higher degree than the rest of bacteria. Inactivation of coliform bacteria proceeded logarithmically with the increasing doses of radiation. A dose of 120 kRad, on the average, was sufficient to reduce the number of coliform organisms to 0.1% of its initial value (i.e., 40 kRad per one log cycle), whereas about twice as high a dose of γ radiation was necessary to attain the same level of inactivation of the total bacterial count, chiefly lactic acid bacteria. After incubation at about 4°C, the number of surviving coliform bacteria was usually lower than the number found immediately after irradiation. In samples stored at higher temperatures (particularly at 37°) the coliforms multiplied very quickly. The coliform bacteria that survived the irradiation showed at least the same catalase activity and thermoresistance as those isolated from unirradiated milk. The results confirmed the generally acknowledged radiosensitivity of coliform bacteria, and point to the possibility of a selective inactivation in milk of this undesirable group, by means of relatively low doses of γ radiation. The dosage used will not materially damage the physical and biological properties of raw milk, and will probably enable production of rennet cheeses from such milk. (BBB)

13826 THE USE OF RADIOISOTOPES IN MEDICINE. Alfonso Pajuelo E. Bol. Junta Control Energia At. (Peru), 9: No. 49, 77-88(Apr.-June 1964). (In Spanish)

A summary description is given of the use of radioisotopes in clinical medicine. Measurement of the blood volume and blood plasma, locating cerebral tumors, determination of the hepatic function, study of the renal function, diagnosis of pernicious anemia, and therapy with radioisotopes are considered. (J.S.R.)

13827 FOOD PRESERVATION. 5. RADIATION. Samuel A. Goldblith (Massachusetts Inst. of Tech., Cambridge). Food Technol., 18: 138-45(Sept. 1964).

Recent developments in food irradiation preservation research are discussed. It is pointed out that the complete elimination of free-radical formation is practically impossible, although techniques are available to minimize those indirect reactions mediated by free-radical and activated-molecule formation. Methods for reducing undesirable side-effects in foodstuffs exposed to ionizing radiations are outlined. Recently, more attention has been given to the possibility of utilizing lower dose levels of ionizing energy. At present there are three workable methods to reduce radiation doses for the processing of foods and yet achieve some possibility of successful preservation. These are discussed. The first utilizes the principle of preserving some foods (rather than sterilizing them) if the bulk of the nonspore-forming organisms that cause spoilage are destroyed, such as the Pseudomonads and the psychrophiles in meat and fish. A second method is based on the complementary effect of ionizing and thermal energy. Thus radiation energy is applied to foods at temperatures above normal (~20°C) and yet below the temperature levels at which protein denaturation occurs, resulting in an increased microbicidal effect. The third method of reducing radiation dose depends upon utilizing some means of sensitizing bacteria to radiation, or upon the use of spore-germinating agents. Results obtained with low-dose sterilization or preservation on both meat and marine products are encouraging, and problems still unsolved are related to the disturbance of the normal flora of these products (allowing only the sporeformers to remain), germination of the spores, and overgrowth of these anaerobes. Unpublished results indicate no deleterious effects on flavor of whole eggs irradiated at the higher temperatures, in contrast to irradiation at room temperature. Success appears likely in the simultaneous application of thermal ionizing energy for the removal of Salmonellae in eggs and egg products, thus offering a solution to a most important public health problem. (BBB)

13828 NEW TYPE LUMINESCENT MATERIAL. I. Abe Genshiryoku Kogyo, 9: No. 12, 55-8(1963). (In Japanese)

A new type of luminous paint that uses a β emitter as the activator was developed. It is cheaper to make, is safer than the radium paints, and its luminosity does not diminish rapidly. The emitters used were: ^{85}Kr as a clathrate; ^{147}Pm as the oxide; and ^{3}H combined with Zr or Ti or as tritiated

organic compound. With the β emitters, Zms or ZnCds plus Cu or Ag, etc. were used. The β emitters damage the luminescent substance less than alpha emitters. (IIC-M.G.)

13829 APPLICATIONS OF INTENSE RADIATION SOURCES TO BIOSYNTHETIC FOODS AND MEDICAMENTS. PART III. Robert Mouton (Universite Libre, Brussels). Ind. At., 8: No. 11, 78-85(1964). (In French)

The use of intense radiation sources for the radiation processing of foods, pharmaceuticals, and medical supplies is discussed. Examples cited include the preparation of antihelminthic and bacterial vaccines, the radiosterilization of thermolabile pharmaceuticals, the treatment of grain for the destruction of insect pests, and the radiation processing of potatoes and onions to increase the storage life. The economic potentialities of radiation processing and the possibility of combining radiation with other chemical and physical treatments are discussed. (C.H.)

13830 SOME APPLICATIONS OF RADIOISOTOPE TECHNOLOGY TO WATER RESOURCES INVESTIGATIONS AND UTILIZATION. George B. Magin, Jr., and Oscar M. Bizzell. Isotopes Radiation Technol., 2: 124-33(Winter 1964-65).

The uses of radioisotopes in water resources investigations are discussed. Sediment density measurements in lakes and streams, tracing the movement of beach sediments, gaging the flow of water through turbines, measurement of water flow in porous media, determining the fluid dynamics of pressurized petroleum reservoirs, and measurement of snow density profiles using radioisotopes are described. Tritium dating of rainwater and use of a deep-water isotopic current analyzer are discussed. (M.C.G.)

13831 PRACTICAL APPLICATIONS OF THE MÖSSBAUER EFFECT. Isotopes Radiation Technol., 2: 140-8 (Winter 1964-65).

The Mössbauer effect is described, and its use in measurement and control technology is discussed. The experimental arrangement used to measure the effect of polarizing magnetic fields and acoustical modulation on nuclear resonance absorption of gamma rays is shown, and results obtained are discussed. (16 references). (M.C.G.)

13832 LARGE SOURCES OF BETA RADIATION FOR CHEMICAL PROCESSING. Isotopes Radiation Technol., 2: 158-69(Winter 1964-65).

The development and potential applications of beta-emitting isotopes for chemical processing are reviewed. Vitreous enamels were studied as source bearers for ^{144}Ce, ^{147}Pm, and ^{90}Sr. It was concluded that some of these formulations are more resistant to chemical attack than Pyrex glass and can withstand considerable thermal and mechanical shocks. Beta-induced grafting of methacrylic acid-styrene copolymer on polyethylene was studied. Some beta irradiators were designed, and their uses are discussed. (M.C.G.)

13833 INCREASED SUSCEPTIBILITY TO STORAGE ROT IN POTATOES AND CARROTS AFTER SPROUT-INHIBITING GAMMA-RADIATION. J. P. Skou and J. Bak Henriksen (Atomenergikommissionen, Riso, Denmark). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138, 48-54 (1964).

The effects of sprout-inhibiting doses (8 kRad) of ^{60}Co γ radiation on susceptibility of these vegetables to storage rot was studied. All experiments with potatoes showed increased rot following irradiation. However, the increase was slight where potatoes of a good keeping quality were used. Rotation during irradiation had only a slight effect on the rotting. The percentage increase in loss by rot during 209 days after irradiation in the autumn approximated that suffered by material irradiated in the spring and subsequently stored for a period of 83 days (i.e., until the same date). The wound-healing ability was lower in late spring than in the winter both in untreated and in irradiated tubers. This was found to be due to a slower suberizing of parenchyma and to failure to form new periderm. Exposure should take place within the containers in which the tubers are stored, thus avoiding wounding during and after irradiation. With carrots, transport and rotation caused a serious increase in rot, which became ruinous when irradiation was added. Washing had an unfavorable effect on untreated carrots, while it appeared to cause a reduction of the number of rotted specimens following irradiation. The species of fungi found to be responsible for attacks are listed in order of relative importance: Botrytis cinerea ≥ Sclerotinia sclerotiorum > Stemphylium radicinum > Fusarium spp. > a few other species. The investigations showed that both vegetables suffer increased susceptibility to storage rot after γ radiation with sprout-inhibiting doses, and that their susceptibility increases when wounded because of a slower development of wound cork and inability to form new periderm. (TCO)

13834 IRRADIATION OF POTATOES: EFFECTS ON SUGAR CONTENT, BLACKENING, AND GROWTH SUBSTANCES. T. A. Truelsen (Atomenergikommissionen, Riso, Denmark). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138, 55-62(1964).

Analyses were made on the contents of sugars up to seven months after irradiation, and attempts made to elucidate the effects of various factors on the radioinduced blackening process in potatoes. The influence of sprout-inhibiting radiation doses on the content of acid growth-inhibiting substance was also studied, and an attempt was made to reverse the inhibition of sprouting by rest-breaking chemicals. There was a strong increase in the sucrose content during the first few days following 8-kRad ^{60}Co γ irradiation. The sucrose concentration rose to a maximum, subsequently decreasing to the normal level over a period of one to three months after irradiation. For the remainder of the storage period the sucrose content was lower in the irradiated than in the untreated tubers. Only minor variations occurred in the glucose and fructose contents. A single dose of 16 kRad did not change the maximum value of the sucrose content as compared to that obtained by irradiation with 8 kRad. Discoloration in irradiated potato tubers increased with increasing dose, on irradiation in the autumn, and with intensive nitrogen fertilization. The blackening process appeared to be independent of boiling and of the temperature used during the storage period within the range of 5–10°C. To determine whether sprout-inhibiting irradiation given in the autumn might prolong the rest period, the changes in the tubers' content of the acid growth inhibitor β were recorded after irradiation. Normally the amount of inhibitor β in the tubers decreases during storage. However, the changes in concentrations of inhibitor β were not affected by a sprout-inhibiting radiation dose. Hence, there is no indication that radioinduced sprout inhibition may be considered as an extension of the natural rest period. (TCO)

13835 A NEUTRON ACTIVATION METHOD FOR SOIL REMOVAL MEASUREMENTS: A COMPARISON OF THE REFLECTANCE METHOD AND THE NEUTRON ACTIVATION METHOD. D. A. Netzel, C. W. Stanley, and D. W. Rathburn (Midwest Research Inst., Kansas City, Mo.). J. Am. Oil Chemists' Soc., 41: 678-83(Oct. 1964).

A nondestructive neutron activation analysis technique was developed to determine the amount of particulate kaolinite clay soil removed from cotton fibers during a wash cycle. The activity of a test cloth after neutron bombardment was used to determine the quantity of clay, which is chiefly aluminum silicate ($Al_2(Si_2O_5)(OH)_4$). Neutron irradiation of the clay results in the activation of the Al atoms within the lattice structure of the clay. A table shows the numerous nuclear reactions which can occur in clay when irradiated by both fast and thermal neutrons from a reactor. Given in the table are: the reactions which can occur, the isotopic abundance of the reactant isotope, the half-life of the product, the cross-section for the reaction, and the type and energy of the radiation emitted by the product. Of the possible reactions which may occur in the irradiation of clay, the thermal neutron irradiation of ^{27}Al is the most feasible reaction to monitor because of the large isotopic abundance of the

reactant and the relatively large cross-section for the nuclear reaction. Because of the short half-life of ^{28}Al, there is no appreciable residual activity of the soiled cloth during the wash cycle. Also, its short half-life allows short irradiation times, thereby minimizing the build-up of the longer half-life activities of the clay and cloth components. The amount of particulate soil present on a piece of cotton cloth before and after the wash cycle is determined by γ scintillation counting of the ^{28}Al, thus providing an absolute method for the determination of the percentage of soil removed. A comparison of this method with the reflectance method was made, and equations relating reflectance to clay content for washed and unwashed soiled cloths were developed for a given surfactant. It was found that the relation of the concentration of the soil on the test cloths and the measured reflectance depends upon whether the cloth has been washed or unwashed. The validity of the applicability of the Kubelka-Munk equation relating reflectance to soil content on cotton fabric was experimentally confirmed for soiled cloths having high reflectivity. (BBB)

13836 EFFECT OF RADIO-COBALT IRRADIATION OF INSECTICIDE DOSES, ON CHEMICAL PROPERTIES OF FLOUR. IV. THE CHEMICAL CHANGES IN FLOUR FAT. Jan Wozniak. Roczniki Panstwowego Zakladu Hig., 15: 581-6(1964). (In Polish)

The influence of Co radiation on the chemical properties of rye flour fats, submitted to radiation of insecticide doses, from 0.1×10^5 R to 1.6×10^5 R and subsequently stored, was tested. Iodine number, Lea number—peroxide content, acidity, and qualitatively oxidation to aldehyde (Kreis test) were determined. No changes in chemical properties of flour fat were detected after exposure to radiation, when compared with control samples of flour. However, a detectable influence of γ radiation of 1.6×10^5 R doses on accumulation of peroxide in flour fat after storage was found. Radiation doses 1.6×10^5 R had no detectable effect on above mentioned properties of flour fat after 80 days of storage. (auth)

13837 PECTIC SUBSTANCES AND PECTIC ENZYMES OF FRESH AND PROCESSED MONTMORENCY CHERRIES. Khalaf Alsoofi Al-Delaimy. Thesis, East Lansing, Mich., Michigan State Univ., 1964. 81p.

The effects of maturation and storage time on the pectic constituents and pectic enzymes of fresh, frozen, and canned red tart cherries (Prunus cerasus L. var. Montmorency) were investigated. The effect of irradiation on the pectic enzymes of frozen Montmorency cherries picked at various stages of maturity was also studied. It was found that the total pectin (TP), the water insoluble pectin (WIP), and the water soluble pectin (WSP) contents of the premature cherries were considerably higher than those of the mature and overmature cherries. The TP content of the premature, mature, and overmature canned cherries was practically the same during the first eight months of storage but decreased slightly after 12 months of storage. There was a small but continuous decrease in the WSP content of both premature and mature canned cherries during the storage. The pectinesterase (PE) activity increased as the stage of maturity of Montmorency cherries advanced. In the frozen cherries the activity showed a slight increase at the end of the fourth month of storage but later it decreased as the storage time of frozen cherries was prolonged for 12 months. The PE activity of the irradiated cherries of various maturity during frozen storage followed the same general trend as the non-irradiated stored frozen fruits, but was slightly higher. The 372-krad dose seemed to enhance the PE activity after the fourth month of frozen storage of the premature and mature cherries. This dose did not affect the PE activity of overmature fruits. The methanol content of cherries increased with time of frozen storage and reached a maximum level at the end of 12 months. The levels of methanol obtained are far below those considered harmful to humans. (Dissertation Abstr., 25: No. 4, Oct. 1964)

13838 METODIKA OPREDELEIYA EFFEKTIVNOSTI PRIMENENIYA RADIOAKTIVNYKH IZOTOPOV. (Methods for Evaluating the Economy and Efficiency of Radioisotopes in Industry). V. I. Postinkov. Moscow, Atomizdat, 1964. 104p.

Technological and economical factors are presented for considering the efficiency and usefulness of isotope applications in industry. An analysis was made of the initial costs, selection of detectors, automation, and safety factors. (22 references). (R.V.J.)

13839 EKONOMICHESKAYA EFFEKTIVNOST ISPOL'ZOVANIYA RADIOAKTIVNYKH IZLUCHENII I IZOTOPOV V NARODNOM KHOZYAISTVE SSSR. (Economic Aspects of the Utilization of Radioactivity and Isotopes in USSR National Industry). G. F. Mikheev. Moscow, Atomizdat, 1964. 223p.

Economic aspects of nuclear power are estimated considering the initial cost and new techniques. Applications of radioisotopes in the automatic control of industrial and technological processes are discussed. Effects of nuclear radiation on various materials and in agriculture are reviewed. A survey is also made of the nuclear geophysics and geochemistry in exploration, prospecting, and development of ore deposits. (R.V.J.)

13840 EFFECTS OF P^{32} IMPURITIES ON THE BEHAVIOR OF TRICRESYL PHOSPHATE-32 AS AN ANTI-WEAR ADDITIVE. E. E. Klaus and H. E. Bieber (Pennsylvania State Univ., University Park). Park Ridge, Ill., American Society of Lubrication Engineers, 1964, Preprint No. 64-LC-2, 8p. (CONF-641007-1)

From American Society of Lubrication Engineers and American Society of Mechanical Engineers Lubrication Conference, Washington, D. C.

Commercial tricresyl phosphate-32 (TCP-32) has been used to illustrate the involvement of ^{32}P in physical absorption and chemical reaction at the bearing surface. Chromatographic analyses of three commercial batches of TCP-32 indicate the presence of appreciable quantities of polar ^{32}P impurities. Thin-layer and iron-powder chromatography have been studied as analytical tools for the quantitative measurement and separation of TCP-32 and its ^{32}P impurities. The effect of the polar ^{32}P impurities on physical absorption on the bearing surface is illustrated as a function of polar ^{32}P impurity concentration. The effect of a variety of surface-active additives on ^{32}P adsorption at the bearing surface has also been studied. The wear properties of TCP, acid phosphates, and acid phosphites in several base stocks have been studied to illustrate the effects of polar impurities on the antiwear properties of TCP. The presence of ^{32}P chemically combined with the bearing metal is suggested by the wear studies with TCP-32. A definite relationship is shown between effective antiwear behavior and a high level of ^{32}P chemically combined with the worn bearing surface. (auth)

13841 THE USE OF NUCLEAR METHODS FOR MOISTURE AND DENSITY MEASUREMENTS IN FOREST PRODUCTS. Jack G. Crump (Nuclear-Chicago Corp., Des Plaines, Ill.). 7p. (CONF-640503-1)

From 5th International Pulp and Paper Symposium, Vancouver, B. C.

The principles of radiation density and moisture measurement are discussed briefly. Some applications of radiation gaging applications in the wood industry are described: particle board weight control, green board sorting, wood chip moisture determination, etc. (D.L.C.)

Power Application

Refer also to abstract 13871.

13842 (HW-SA-3416) RADIOISOTOPIC SPACE POWER—PROSPECTS AND LIMITATIONS. E. D. Sayre and C. A. Rohrmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 13, 1964. Contract AT(45-1)-1350. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The advantages of radioisotopes for power applications

are outlined. The engineering properties of radioisotopes for such applications are reviewed: half life, power density, hazards, availability, and cost. Design and materials considerations for radioisotopic space power systems are next discussed. Finally, safety aspects and future prospects of radioisotopes are discussed briefly. (D.L.C.)

13843 (SAN-366-1) THE CESIUM-137 POWER PROGRAM. Final Report. (Royal Industries, Inc., Pasadena, Calif.). May 1964. Contract AT(04-3)-366 242p. Dep. (mn); $6.00(cy), 5(mn) OTS.

Activities in a program to design a compact and lightweight thermoelectric generator, power by ^{137}Cs to safely provide uninterrupted power, in the five watt (e) range, to an undersea seismic station are described. The ^{137}Cs thermoelectric generator was not capable of delivering 5 w. The other design objectives met during the research are summarized. A chemical fuel form was developed which render radiocesium virtually inert to leaching by either fresh or sea water. Cesium borosilicate formulation, process time, temperature requirements, and specialized equipment were developed. An inoperative, full scale model of a Cs generator was fabricated. The model represented a feasible approach to generator design and one which closely resembled the prototype device. A radiation shield was designed, predicated upon the energy levels and relative quantities of gamma and bremsstrahlung radiation anticipated for the radiocesium fuel. Replating the fully fueled (26,000 curies) u core was achieved so that a complete coating of Ni was deposited and the fueled core rendered safe. The overall generator size and weight, although considerably less than existing thermoelectric generators for terrestrial use, came well within the design specifications of 500 lb total weight, and an outside diameter of 13 in. The generator proper was surrounded and contained within a pressure shell which, though light in weight, was capable of withstanding ocean pressures to 36,000 feet depth. A thermoelectric module was developed that provided 2.75 w. A safety analysis was prepared for those credible accidents with which the generator might be involved. Activities in the program have helped to advance the technology of both isotopic power and fission product utilization. (auth)

13844 ISOTOPIC PROPULSION. John S. Martinez (TRW-Space Technology Labs., Redondo Beach, Calif.). Space/Aeron., 42: No. 6, 77-82(Nov. 1964).

The use of radioisotopes to heat propellants for space propulsion is discussed, with particular consideration of the Poodle engine now under development. The specific impulse available with gaseous, liquid, and subliming propellants is considered, together with safety and technical problems, thermal control, and isotope selection. (D.C.W.)

Separation and Production

Refer also to abstracts 13201 and 13534.

13845 (ANL-6932) DATA RELATING TO THE PRODUCTION OF TRANSCURIUM ELEMENTS IN HIGH NEUTRON FLUXES. D. C. Stewart, R. W. Anderson, and John Milsted (Argonne National Lab., Ill.). Sept. 1964. Contract W-31-109-eng-38. 24p. Dep.; $2.00(cy), 1(mn) OTS.

Data pertinent to the encapsulation, irradiation, and processing of targets composed of trans-Np elements are calculated using computer programs. The data refer to high-flux neutron irradiation of these targets in order to produce trans-Cm elements. (T.F.H.)

13846 (CEA-R-2562) LOIS DE SEPARATION ELEMENTAIRES EN DIFFUSION GAZUSE. (Fundamental Laws of Separation by the Gaseous Diffusion Process). Georges Bouligand (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). Aug. 1964. 44p. Dep.(mn).

Using the Knudsen's law for the flow of each component of a gaseous mixture through a porous membrane, the overall separation laws and the separation power for one stage of diffusion is derived. Various types of stages differing by the geometrical configuration and the flow nature are considered. For the sake of simplicity physical phenomena causing a loss of separation efficiency are neglected. Computation results show the advantages of counter-current type stage with one entering and two leaving flows. A more refined theory of separation can be derived with the same basis of this work. (auth)

13847 SEPARATION OF ^{32}P FROM PILE-IRRADIATED ELEMENTARY SULPHUR. L. Vasaros (Central Research Inst. for Physics, Hungarian Academy of Sciences, Budapest). Acta Chim. Acad. Sci. Hung., 42: 181-9(1964).

A method was developed for the production of carrier-free ^{32}P from elementary sulfur irradiated in a reactor. The method is based on the principle that if the polysulfide solution of irradiated sulfur is destroyed by hydrochloric acid, sulfur is quantitatively precipitated from the solution, while the phosphorus isotope is retained in the form PO_4^{3-}. The samples produced with this method were of very high purity. (auth)

13848 HANFORD ISOTOPES PLANT. C. A. Rohrmann. Isotopes Radiation Technol., 2: 99-123(Winter 1964-65). (HW-SA-3607)

The Hanford Waste Management Program produces large quantities of crude and purified concentrates of ^{90}Sr, ^{137}Cs, ^{144}Ce, and ^{147}Pm. A design was developed and costs estimated for an isotope processing plant, which would be capable of high-volume production of encapsulated heat-source forms of ^{90}Sr, ^{137}Cs, ^{144}Ce, and ^{147}Pm. Drawings of the conceptual plant are presented. The waste management process will produce, by solvent extraction and ion exchange, two streams of interest: an aqueous stream containing a mixture of Sr and Cs at about 98% recovery and an aqueous stream containing the rare earth isotopes including cerium and promethium, with 90 and 80% recovery, respectively. Methods for processing these further are described, and flowsheets presented. Alternative products and processes are discussed. (M.C.G.)

13849 ISOTOPE SEPARATION, THE FINAL STEP IN RAW MATERIAL PRODUCTION FOR NUCLEAR TECHNOLOGY. A. P. Murrenhoff (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 6: 553-4(Dec. 1964). (In German)

The function of isotope separation in the nuclear technology and general points regarding the suitability of isotope separation processes for different separation problems are discussed. (auth)

13850 ISOTOPE SEPARATION BY DISTILLATION AND CHEMICAL EXCHANGE. A. P. Murrenhoff (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 6: 554-7 (Dec. 1964). (In German)

The principles of isotope separation by distillation and chemical exchange are reviewed, together with important applications to the separation of light element isotopes (except the H/D-separation). (auth)

13851 INDUSTRIAL PRODUCTION OF DEUTERIUM. A. P. Murrenhoff (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 6: 558-60(Dec. 1964). (In German)

A review of an important process for the industrial production of deuterium is presented. (auth)

13852 THE SEPARATION CASCADES IN DIFFUSION PROCESSES. G. Dickel (Universitat, Munich). Kerntechnik, 6: 561-5(Dec. 1964). (In German)

For all separation methods based on diffusion processes the separation cascade with optimum efficiency can be obtained from a diagram. For the separation-tube method and the counter-current centrifuge the optima are given by a multitude of solutions containing two parameters. The cascades differ from each other only in their dimensions. (auth)

13853 THE ELECTROMAGNETIC SEPARATION OF ISOTOPES. H. Wagner (Universitat, Marburg, Ger.). Kerntechnik, 6: 566-70(Dec. 1964). (In German)

The development of electromagnetic separation of isotopes is surveyed. Physical principles of the method are presented. The ion paths are described ionoptically. The in-

fluence of the ion space charge on separation and space charge compensation are discussed. The data from three ion sources are compared. The techniques of ion collection and several auxiliary parts of the separator are described. The tasks of large-scale and laboratory-sized separators are enumerated. (auth)

13854 ISOTOPE SEPARATION BY GAS CENTRIFUGES. O. Boettger (AEG Forschungsinstitut, Frankfurt am Main). Kerntechnik, 6: 571-6(Dec. 1964). (In German)

As a measure for separating effect the separation potential is introduced. The principles of operation of a gas centrifuge are shown and the theoretical separation potential given. It was found to depend on the mode of operation what fractions of the theoretical separation potential may be reached. The centrifuge method and the diffusion method for the separation of UF_6 were compared as regards economics. (auth)

13855 A CONTINUOUSLY WORKING INSTALLATION FOR THE SEPARATION OF ISOTOPES IN THE GAS PHASE. J. Etterich (Universitat, Kiel). Kerntechnik, 6: 577-81 (Dec. 1964). (In German)

The plant described makes possible a continuous process for the separation of isotopes in the gas phase. One turbomolecular pump at a time is arranged at both sides of the separation zone. The density gradient effected by the turbines provides for removal of gases from separation zone. The enriched as well as the exhausted gas components are pumped to local separated catchers after the separating process is performed. The natural proportion of the occurrence of $^{12}C^{16}O_2$, and $^{13}C^{16}O_2$, and $^{12}C^{16}O^{17}O$ could be shifted by about 0.8%. (auth)

13856 OBTAINING CARRIER-FREE Fe-59. I. Gălăteanu, G. Fodor, C. Chiotan, and M. Cristu (Institut de Physique Atomique de l'Académie de la Republique Populaire Roumaine, Sos. Măgurele). Rev. Roumaine Chim., 9: 601-10(Oct. 1964). (In Rumanian)

The preparation of high-purity carrier-free ^{59}Fe for medical purposes is described. The high-activity ^{59}Fe was separated from ^{60}Co, produced at the same time in irradiation of cobalt, by extraction with organic solvents (isopropyl ether). The last traces of ^{60}Co were eliminated by absorption on anionite (Dowex-1). The solution of ^{59}Fe resulting was found to be pure with no trace of radioactive impurities. (tr-auth)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 12905, 13725, and 14557.

13857 (AEEW-M-467) THE FLIC1 CONVERSION CODE. J. C. Basher (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Aug. 1964. 24p. Dep.; $0.50 (BIS); 2s. 6d. (HMSO).

The FORTRAN II program, FLIC1, which converts programs written in one dialect of FORTRAN to another dialect of the same language, is described. Particular translation processes considered are those from existing dialects (FORTRAN II and S2) to EGTRAN1—the dialect to be used initially on the Winfrith KDF9. The basic version of the program replaces FII or S2 statements where these are different from, but in one-to-one correspondence with, E1 statements. Other statements which need changing are flagged. (auth)

13858 (HW-80246) MIDAS—A SIMPLIFIED METHOD FOR PROGRAMMING A 7090 COMPUTER FOR SIMULATION OF DYNAMIC SYSTEMS. R. D. Benham (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 6, 1964. Contract AT(45-1)-1350. 73p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A description is presented of the analog computer programming techniques required for using the MIDAS system on an IBM 7090 digital computer. The MIDAS program provides a method for obtaining digital-computer solutions for systems of ordinary differential equations. The program makes the digital computer operate similarly to an analog computer. (T.F.H.)

13859 (HW-84448-10) ANALOG COMPUTING APPLICATIONS—OCTOBER 1964. R. A. Harvey (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 27, 1964. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Analog-computer studies of ^{131}I distributions in man; river routing and control; wind turbulence; and PRTR transients are described. (T.F.H.)

13860 (IS-995) ADAPTIVE SAMPLING IN DIGITAL CONTROL. Kenneth Allen McCollom and R. M. Stewart, Jr. (Ames Lab., Ames, Iowa). Aug. 1964. Contract W-7405-eng-82. 99p. Dep.; $4.00(cy), 2(mn) CFSTI.

This study provides a set of design curves from which effective digital control for an experiment can be obtained and at the same time efficient use of a digital computer shared with other experiments can be realized. The state variable technique is used as both a design method for obtaining the design curves for adaptive sampling and for predicting the states for control of the process. The adaptive sampling technique is defined to be that choice of constant prediction period that will satisfy control specifications over a specified range of system conditions. The complete range of system operation is divided into a number of classes for which criteria can be devised for determining when the system is in each class. In each class the prediction period is no smaller than that required over the range of the operation of the class. The objective of the adaptive sampling is to use the digital computer for control as little as possible yet maintain the system control specifications. The method developed is general enough to allow use by a control engineer who has, or can develop, an adequate mathematical model for the process. The model is reduced to a set of first order differential equations and then converted to Laplace Transform block diagrams. The knowledge of the behavior of a single first order differential equation, or similarly a single first order Laplace Transfer block, for a reasonable number of deterministic inputs allows the control engineer to analyze the control behavior of his complete block diagram one block at a time assuming piecewise constant inputs to the block. Using the method, an interesting and useful characteristic is demonstrated for process systems which have particles or components that originate at the input of the process, are carried through the process in space and time and finally are expelled from the process never to return. These processes are commonly described by a set of nonlinear differential equations with time-varying coefficients. Solving this set of equations simultaneously is both a long and difficult task. For processes with the characteristics described above, this set of nonlinear differential equations can be uncoupled and the resulting sets solved in sequence. The experiment on which the adaptive sampling is demonstrated, the set of uncoupled equations prove to be individual first order differential equations that are linear. (auth)

13861 (LADC-6207) THE EIGENVALUE PROBLEM FOR SUBLINEAR OPERATORS WITH UNIFORMLY SYMMETRIZABLE DERIVATIVES. George H. Pimbley, Jr. (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A differential equation problem is considered and shown to be equivalent to a Hammerstein equation. Some of the spectral properties of the nonlinear eigenvalue problems are studied for cases in which the kernels of the Hammerstein equation are quite general. The theory is presented in a Hilbert-space formalism. (T.F.H.)

13862 (SC-R-64-1348) THE CUMULATIVE BINOMIAL DISTRIBUTION COMPUTER. J. O. Muench (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract [AT(29-1)-789]. 20p. Dep.; $1.50(OTS).

Sandia Corp. Monograph.

A slide-rule-type nomograph is presented that can be used to find approximate solutions to simple probability problems. (T.F.H.)

13863 (TID-21413) ICR QUARTERLY REPORT, NUMBER 2, AUGUST 1, 1964. Nicholas C. Metropolis (Chicago. Univ. Inst. for Computer Research). Contract AT(11-1)-614. 231p. Dep.(mn); $6.00(cy), 4(mn) OTS.

Emphasis in the MANIAC III project was mainly on operations. Efforts were also devoted to engineering design, construction, and testing of prototypes for future computer improvements. Work in a cyclotron experiment with an on-line computer is described, and problems associated with accelerator beam steering are discussed. Experience with the LISP 1.5 programming system is summarized, and progress on the CDC 3600 Algol compiler is reported. Discussions are included on error estimation in computer calculations, methods in the solution of matrix operator equations, stability testing of sampled data systems using the matrix power method, digital and analog solutions of linear equations, progress in an inter-nuclear cascade program, mu-mesic x-ray data reduction, cosmic electron-positron data reduction, congruence of mod P^3, algorithm for mathematical programming, interpreting results of experiments on the parameters of theory and theory of pattern recognition. (J.R.D.)

13864 SUMMARY OF THE EANDC CONFERENCE ON AUTOMATIC PROCESSING OF NUCLEAR DATA. L. J. Likofsky (Columbia Univ., New York). Nucleonics, 22: No. 12, 48-52(Dec. 1964).

Recent evolution of data acquisition techniques and problems of data reduction, emphasizing the role of computers, are reviewed. Surveys of applications in high- and low-energy physics, use of systems including delayed totalizing (magnetic tapes) and other fixed program types, applications in feedback and control operation, hardware developments, and programming developments are reported. Developments in the design and performance of digitizing equipment, storage systems, and associative memories are discussed. (M.J.T.)

13865 FEATURES OF AVAILABLE SMALL ON-LINE COMPUTERS. Jules S. Levin (Los Alamos Scientific Lab., N. Mex.). Nucleonics, 22: No. 12, 53-6(Dec. 1964).

A survey is given of the characteristics of several small on-line computers available from United States and European manufacturers. The survey was limited to word-oriented binary-addressed computers that can perform logical as well as arithmetic operations and that cost less than $150,000. The process of evaluation of the computers is outlined, and a description of their basic features is given. A table is presented of memory, processor, interrupts, and input/output characteristics of the surveyed computers. (M.J.T.)

13866 THE NBS ON-LINE SYSTEM—DESIGNED FOR FLEXIBILITY. Nucleonics, 22: No. 12, 57-62(Dec. 1964).

An on-line system was developed for the NBS Linac, designed for easy changes in both hardware inputs or computer programming. A block diagram of the details of input-data interface is given. The design, operation, and advantages of the system are discussed. The programming philosophy of the computer is considered, emphasizing the flexibility of its use in different situations. (M.J.T.)

13867 ON THE CALCULATION OF ERROR INTEGRALS. J. Patry and J. Keller (Eidgenossisches Institut fur Reaktorforschung, Wurenlingen, Switzerland). Numerische Math., 6: 89-97(1964). (EIR-69) (In German)

An algorithm for the calculation of error integrals on the real axis is presented and demonstrated. (D.C.W.)

13868 RADIATION RESISTANT COMPUTER DEVELOPMENT. John King and John Rogers (Sperry Gyroscope Co., Great Neck, N. Y.). 15p. (CONF-640910-1)

From International Convention of Military Electronics, Washington, D. C.

A digital computer was developed which is resistant to steady-state nuclear radiation levels. A logic circuit was tested successfully at 2×10^{16} nvt steady-state and 5×10^{7} rad/sec pulsed radiation. (D.L.C.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 13199 and 14765.

13869 (ASD-TDR-63-269) TOTAL HEMISPHERICAL EMITTANCE AND NORMAL SPECTRAL EMITTANCE ($\lambda = 0.65\mu$) OF OXIDATION-PROTECTIVE COATINGS. N. J. Alvares (Naval Radiological Defense Lab., San Francisco). Mar. 1963. Contract MIPR-33-657-2-RD-155. 29p. (AD-423179). $1.00(OTS).

Measurements of the variation of total hemispherical emittance and normal spectral emittance ($\lambda = 0.65\mu$) with increasing temperatures have been made on some pack-cementation type oxidation-resistant coatings for the refractory metals, molybdenum, tungsten, niobium, and tantalum. The coatings tested include the Pfaudler Company's PFR-6, Chance-Vought Corporation's CV IV single and double cycle, and Chromizing Corporation's Durak-B, MG-F, and KA. The normal spectral emittance ($\lambda = 0.65\mu$) of the coatings on disc samples, was determined with a micro-optical pyrometer, which was sighted into a black body hole, drilled in the sample and then onto the adjacent area. The total hemispherical emittance of the coatings on ribbon specimens was found by use of a calibrated total radiation pyrometer, which sampled the energy radiated from a uniform temperature region established about the center portion of the electrically heated ribbon specimen. The diffuseness of the surface of the various coatings was found by taking angular distributions of the radiation emitted from the center portion of the sample ribbons at various temperatures with the total radiation pyrometer. (auth)

13870 (BM-RI-6570) ELECTROREFINING BERYLLIUM. Two-Cycle Electrolysis. M. M. Wong and D. A. O'Keefe (Bureau of Mines, Boulder City Metallurgy Research Lab., Nev.). June 1964. 10p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

To obtain beryllium metal of higher purity, flakes produced from electrorefining scrap metal were used as cell feed for a second cycle of electrorefining at 500°C in an electrolyte composed of 51.7 mole-percent LiCl, 36.9 mole-percent KCl, and 11.4 mole-percent $BeCl_2$. Metallic impurities in the flakes totaled more than 108 ppm, and the metallic impurities in the metal obtained from the two-cycle electrorefining were, with the exception of 35 ppm of calcium, below the spectrographic determination limits. (auth)

13871 (BMI-1691(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING AUGUST 1964. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Sept. 1, 1964. Contract W-7405-eng-92. 52p. Dep.; $3.00(cy), 2(mn) OTS.

Progress is reported on development of reactor materials and components, reactor fuel development, radioisotope and radiation applications, development and testing of coated-particle fuel materials, corrosion studies of fluoride volatility processes, gas-cooled reactor development, and development of radioisotopic power sources. (N.W.R.)

13872 (BNL-892) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Vol. 2, No. 4. (Brookhaven National Lab., Upton, N. Y.). Aug. 1964. Contract AT-30-2-GEN-16. 70p. Dep.; $3.00(OTS).

Reviews are presented of 32 papers on fluid dynamics, heat transfer, materials development and corrosion, instrumentation, component development, system studies, chemical analysis and chemistry, fabrication techniques, and physical properties and thermodynamics. (N.W.R.)

13873 (CONF-631201(p.65-71)) STATUS OF PLUTONIUM TECHNOLOGY. Harvey A. Wagner (Detroit Edison Co., Detroit).

A review is given of available information on plutonium as a reactor fuel, including its availability, demand, and potential worth. Current research and development programs are also discussed. (C.E.S.)

13874 (EURAEC-1179) URANIUM MONOCARBIDE SHAPING AND IRRADIATION STUDY. Final Report No. 2, March 1, 1962–December 31, 1963. J. P. Dumas, B. Mansard, and P. Rousset (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Work Performed under United States–Euratom Joint Research and Development Program. Contract 080-62-3-RDF. 110p. Dep.(mn); $4.00(cy), 2(mn) OTS.

Two irradiations in the Melusine reactor were made to 1000°C. In spite of the low combustion rates attained, two phenomena were revealed. In the case of a sample of uranium monocarbide containing 2000 ppm of oxygen, a swelling of up to 4% for an integrated combustion rate as low as 400 Mwd/t was measured. This swelling seemed to be bound to the reaction between the carbon and the oxygen present in the monocarbide, this reaction being catalyzed by the irradiation. On a product containing 600 ppm of oxygen, the irradiation up to a rate of 140 Mwd/t caused a contraction of the material containing from 4.54 to 4.7% of carbon. This contraction was explained by the precipitation of the uranium in solution in the monocarbide. This precipitation is remarkable by its rapidity and leads to the idea that the radiation has a catalytic effect. All the post-irradiation examinations go to show an evolution of the irradiated material towards thermodynamic equilibrium. In the same way the study of the diffusion of fission gases by extraction on a bench loop after irradiation showed that uranium carbide retained these gases much better than uranium dioxide, and that their release between 1400 and 1900°C was always governed by the laws of diffusion. Three experimental devices are described: an irradiation device making it possible to place the uranium carbide rods directly into the EL_3 reactor, a heat conductivity measuring device, and an electrical conductivity measuring device adapted for use on irradiated materials. The preparation of uranium monocarbide by sintering-extrusion is described and evaluated. (auth)

13875 (GA-4022(Pt.1)) ADVANCED, GRAPHITE-MATRIX, DISPERSION-TYPE FUEL SYSTEMS. Annual Report, April 1, 1962–March 31, 1963. E. E. Anderson, J. O. Gardner, P. E. Gethard, W. V. Goeddel, J. R. Hooker, H. K. Lonsdale, R. J. Price, G. R. Tully, J. L. White, and L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 1, 1963. Contract AT(04-3)-167. 116p. Dep.(mn); $4.00(cy), 3(mn) OTS.

A hot-working device for the deformation of graphite bodies in compression was developed to investigate the feasibility of applying hot-working techniques to the fabrication of graphite-matrix fuel bodies with improved properties. This device was used to deform cylindrical specimens of a typical matrix graphite and matrix graphite containing ZrC particles to strains of 30% at 2400 to 2900°C. The graphite bodies containing ZrC particles were found to be more plastic near 2500°C than similar bodies containing no carbide particles. Studies of the furfuryl-alcohol-resin impregnation of hot-pressed graphite-matrix fuel compacts containing fuel particles coated with pyrolytic carbon (PyC) have shown that the compacts can be impregnated without damage to the coated particles. Compacts with permeability levels varying as low as 3.5×10^{-6} cm²/sec are undergoing fission-product-release testing to permit correlation of performance with permeability and electron- and optical-microscopic examination aimed at identifying the components in the bodies. Chemical studies of pitch binders for graphite are being conducted to ascertain the composition and function of the binders and the methods by which they may be modified to produce compacts with improved properties. A solvent-

extraction process was established for the separation of pitch into three basic fractions and two subfractions. Liquid-solid elution chromatography was used to effect a further separation of the molten fraction of pitch into seven groups of compounds. Infrared-spectrographic analyses showed that these volatile components of pitch were predominently multiringed, aromatic hydrocarbons. Some 18 pure organic compounds of the type found in pitch were tested as binders for hot-pressed graphite compacts. A sample of pitch given a prepyrolysis treatment was separated and examined. Comparison with the components from untreated pitch indicated that chemical changes had taken place in the pitch during pyrolysis. The use of a free-radical catalyst to upgrade the binding quality of pitch was investigated briefly. X-ray diffraction studies were conducted on samples of whole pitch and pitch insolubles to determine the changes in structural ordering on further heating. The fission-product release of spherical single-crystal UC_2 particles was studied by postirradiation annealing of neutron-activated samples and by exposing samples to a steady rate of photofission, using 30-Mev x-rays from an electron accelerator. Enhanced fission-product release was observed in a number of instances for UC_2 particles at 1800°C. This was correlated with a change in microstructure, with multicrystalline UC_2 particles showing a greater tendency to release fission products. Tentatively, it is believed the single-crystal particles may be considered a diffusion unit as defined by its geometrical boundaries. Experiments were conducted to measure the rate of diffusion of uranium in pyrolytic graphite as a function of temperature. The technique consists in annealing diffusion couples made by pressing together disks of pyrolytic graphite and a drop-cast button of $^{235}UC_2$. Uranium distribution in the pyrolytic graphite disk is determined by neutron-activation analysis of thin slices of the disk. Studies were made, applying electron microscopy in combination with optical metallography, to define the microstructural components of impregnated compacts. (auth)

13876 (GA-4930(Pt.1)) ADVANCED, GRAPHITE-MATRIX, DISPERSION-TYPE FUEL SYSTEMS. Quarterly Progress Report for the Period Ending December 31, 1963. J. C. Bokros, W. V. Goeddel, J. R. Hooker, H. K. Lonsdale, J. L. White, and L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Jan. 15, 1964. Contract AT(04-3)-167. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The dependence of the structure of pyrolytic carbon deposited in a fluidized bed on independent coating variables was studied. The results to date may be summarized as follows: The anisotropy factor increases with methane partial pressure for bed temperatures below 1600°C, decreases with methane partial pressure for bed temperatures above 1600°C, and increases with surface area in the bed at all bed temperatures. The density increases with methane partial pressure for bed temperatures below 1600°C, and decreases with increasing methane partial pressure for bed temperatures above 1600°C. The apparent crystallite size increases with temperature for a given methane partial pressure, and increases with decreasing methane partial pressure for bed temperatures above 1600°C. The importance of the structure of pyrolytic carbon to the performance of coatings under various environmental conditions was considered. Studies of the mechanical properties of pyrolytic-carbon coatings showed that the flexural modulus decreases rapidly with increasing coating temperature. An accompanying smaller rate of decrease in fracture stress results in a net rise in fracture strain as the coating temperature increases. Further studies of the hot-working characteristics of a graphite body containing ZrC particles showed that the improvements in properties caused by hot-working are not as strong as observed for the matrix graphite alone. Free-radical catalysts are being utilized to obtain improved bonding from the pitch in hot-pressed graphite-matrix fuel compacts. Various heat-treatment schedules and binder concentrations are being investigated to learn the conditions for the most efficient pyrolysis of the binder. Further tests using pure organic compounds as binders confirmed the superiority of truxene-type compounds in producing compacts of high density and strength. Previous studies of the kinetics of fission-product release from single-crystal UC_2 particles were extended to investigate the effect of UC_2 particle size on the rate of release. In general, the rate of release decreased with increasing particle size over the range 150 to 300 μ. However, particles in the 300 to 350 μ size range showed an anomalously high rate of release. (D.L.C.)

13877 (GA-5016(Pt.1)) ADVANCED, GRAPHITE-MATRIX, DISPERSION-TYPE FUEL SYSTEMS. Annual Report, April 1, 1963–March 31, 1964. J. C. Bokros, W. V. Goeddel, J. R. Hooker, H. K. Lonsdale, J. L. White, and L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. 77p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The thermal stability and fission-product retention of coated fuel particles and graphite-matrix fuel bodies are investigated in order to evaluate the factors that determine the lifetime and limit the temperatures of graphite-matrix fuel systems. The structure of pyrolytic carbon deposited in a fluidized bed is characterized in order that its physical and mechanical properties can be related to structure. The feasibility of applying hot-working processes to the fabrication of graphite-matrix fuel bodies of improved properties is determined, and the properties of hot-worked bodies containing carbide particles are being defined. The synthesis and evaluation of improved binders for graphite are studied, and the optimum processing conditions for the preparation of graphite compacts with these binders are being determined. The rates of diffusion of uranium in pyrolytic carbons typical of those employed in graphite-matrix fuel systems are determined. The release of fission products from crystalline UC_2 and UC_2 particles is studied as a function of particle and crystalline size and coating type, and graphite-matrix fuel compacts are evaluated. (N.W.R.)

13878 (GA-5606(Pt.1)) ADVANCED, GRAPHITE-MATRIX, DISPERSION-TYPE FUEL SYSTEMS AND RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending August 14, 1964. J. C. Bokros, W. V. Goeddel, H. K. Lonsdale, R. E. Norman, R. J. Price, J. L. White, and L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 1, 1964. Contract AT(04-3)-167. 42p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Measurements of the mechanical properties of pyrolytic C deposited under various conditions show that the flexural modulus and the fracture stress decrease with increasing deposition temperature while the fracture strain increases, causing a net increase in elastic strain at fracture. The effect of annealing on the mechanical properties of pyrolytic C was studied. It was found that the largest changes in mechanical properties occur in material deposited at relatively low temperatures (1350 and 1450°C), where annealing causes a sharp decrease in modulus, a decrease in fracture stress, and a slight increase in fracture strain and that the changes in the mechanical properties of material deposited at high temperatures are relatively small. Seven representative structures of pyrolytic C were selected for tests of stability during exposure to high-energy neutron flux. The specimens were prepared and preliminary property measurements are being made. Graphite samples having various preferred orientations were prepared for irradiation testing in a capsule. Dimensional changes in the radial, longitudinal, and circumferential directions will be measured and compared with the dimensional effects predicted from preferred-orientation data. A previously derived relation between the preferred orientation and the Young's modulus of graphite bodies was tested for specimens of plastically deformed pyrolytic C. Calculations of Young's modulus from measurements of the preferred orientation of these extremely anisotropic materials yield values in good agreement with those determined experimentally. In current studies of the hot-working characteristics of graphitic materials, bodies of high pitch content were hot-worked and the properties are being measured. Graphite specimens with various additives, e.g.,

NbC, ZrC, and Ni, were prepared to explore further the enhanced plasticity of carbide-containing graphite observed in previous work. Initial measurements of the tracer diffusion coefficients of Th in a laminar-type pyrolytic C were made; these values are significantly lower than those reported for U diffusion. (auth)

13879 (GEMP-42A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 42, PART A. (General Electric Co. Advanced Technology Services, Cincinnati). Dec. 18, 1964. Contract AT(40-1)-2847. 34p. Dep.; $2.00(OTS).

Further studies of the elastic constants of unirradiated BeO were completed and the constants of the Hasselman equation, which relates the elastic constants to specimen porosity, are presented. In studies of irradiated BeO, measurements of heat content indicated no change in the enthalpy of AOX-grade and UOX + MgO-grade BeO specimens up to 900°C following irradiation at 1000°C to about 10^{21} nvt (≥1 Mev). Further developments on the kinetics of the radiation-induced expansion are discussed. Heat soaking treatments of evacuated arc-cast Ta cans for 125 and 160 hours at 2400°C and under a pressure differential of 0.8 atmospheres of Kr containing ^{85}Kr indicated the permeation coefficient of Kr through Ta to be less than 1.15×10^{-12} ml of gas at STP per cm^2 of surface area per mm of wall thickness per cm of Hg pressure per sec. By introducing Kr containing ^{85}Kr into a self-resistively heated arc-cast Ta cathode via glow discharge, a diffusion coefficient of approximately 10^{-13} cm^2/sec at about 1700°C was calculated from the sub-micron distribution of activity in the sample. Beryllia fuel elements containing 7 to 25 volume percent UO_2-ThO_2 and $UO_2-ThO_2-Y_2O_3$ had a maximum of 0.6% UO_2 loss in 3000-hour fuel retention tests at 1200°C in air. Transpiration measurements at 1650°C indicate fuel retention capability of the Y_2O_3-containing compositions can be increased by sintering at higher than normal (1675°C) temperatures. Two irradiation tests of BeO-base fuel elements containing 25 vol % $UO_2-THO_2-Y_2O_3$ have operated satisfactorily for 707 hours at 1000° to 1250°C in the ETR. (auth)

13880 (HW-81602) CERAMICS RESEARCH AND DEVELOPMENT OPERATION. Quarterly Report, July–September 1964. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Contract AT(45-)-1350. 78p. Dep.; $3.00(OTS).

Progress is reported in the following sections: ceramics fuel research studies, irradiation behavior of ceramic fuels, EBWR plutonium recycle fuel, PRTR fuel element fabrication and performance, and fabrication of fuel for physics studies. Separate abstracts are prepared for each section. (N.W.R.)

For abstracts of individual sections see: 13881, 13882, 14083, 14830, and 14883.

13881 (HW-81602(p.2.1-27)) CERAMIC FUEL RESEARCH STUDIES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Specimens were prepared for use in studies of the ternary, Pu–O–N. An experiment is in progress to synthesize pure PuO. The thermal expansion of a UO_2 single crystal was measured from 300 to 1600°C. The visible and infrared absorption spectra for uranium dioxide were remeasured between 0.6 and 2.5 μ with increased precision. Uranium dioxide with O/U as low as 1.93 is fabricated by heating UO_2 and uranium metal at 2300°C in a vacuum. Penetration of uranium and UO_{2-x} into tungsten at 2600°C was found to be less extensive when the tungsten powder was heated in hydrogen prior to pneumatic impaction. Several Cr–Ni alloy-clad $UO_2-(Cr-Ni)$ cermet discs were prepared by a pneumatic impaction technique. A technique for mounting americium samples for Guinier and Debye-Sherrer x-ray analysis was devised. The microhardness of the (100) plane of ThO_2 single crystal is 871 ± 80 KHN (100 g load). Results of $BeO-PuO_2$ impaction studies indicate that the BeO matrix will bond when impacted at 1200°C and that small amounts of PuO_2 can be safely handled in the presence of BeO. A method was developed for producing a fast reactor fuel material by dry ball-milling UO_2 and PuO_2 powders followed by pneumatic impaction. A simplified characterization and testing procedure was developed for materials used in mixed oxide fuel rods. The bulk density and gas content of −325 mesh PuO_2 powder prepared by oxidation of the metal were found to be 4.83 g/cc (42% TD) and 2.0 cc/g, respectively. UO_2 powders prepared from oxidation of the metal are now readily densified by the pneumatic impaction process after a wet hydrogen, high temperature treatment that removes gaseous impurities. Excess oxygen in nonstoichiometric sintered UO_2 fragments, introduced both by roasting and by adding U_3O_8, was found to equilibrate among the various UO_2 particle size fractions. (auth)

13882 (HW-81602(p.6.1-3)) FABRICATION OF FUEL FOR PHYSICS STUDIES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

High density fuel for 150 PRCF (2 wt % PuO_2-UO_2) fuel rods was prepared using vertical coupling to vibrationally compact the fuel to required densities. Fabrication of the 20 wt % Pu–Al Phoenix fuel discs was completed; 8100 discs with a 5.0 cm diameter and 0.051 cm thickness were fabricated. Sixty-nine wt % UO_2–graphite discs were fabricated to establish fabrication techniques required for the HTLTR control rods. The fabrication of aluminum, gold, and lithium standards for physics experiments was completed. (auth)

13883 (HW-81984(p.9.1-6)) MATERIALS DEVELOPMENT, CORROSION, AND HEAT TRANSFER STUDIES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Corrosion testing of Zr-alloy pressure tubes, corrosion and mechanical properties testing of stainless steel, Ni alloys, and Al alloys, corrosion of Haynes 25, and Hastelloy X by N_2, CO_2, and water vapor, and results of Mo oxidation tests are reported. Corrosion tests of Al-clad fuel elements in the C-1 loop were completed. In PRTR materials development and engineering, Zircaloy-2 corrosion by water at 275°C is reported along with tests to determine the effects of pressure on the corrosion of Fe- and Ni-base alloys in superheated steam. Hydrogen diffusion studies and tests of ductility on Zircaloy-2 were continued. Completion of the irradiated tube burst test facility is reported. Results of the preliminary phases of a high-temperature and -pressure critical flow program are also reported. Results from an analysis of data on two test sections in which upstream boiling burnout was detected at low pressures are included. (J.R.D.)

13884 (HW-84106) THE TECHNOLOGY OF THORIA AND THORIA–URANIA COMPOSITIONS. (A Review of the Literature). T. W. Evans (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 18, 1964. Contract AT(45-1)-1350. 40p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The properties and technology of thoria and thoria–urania compositions that relate to their use as a reactor fuel or fertile material are reviewed. Thoria and thoria–urania compositions high in thoria are very stable thermally and chemically. The availability of low cost ores for many years seems assured. The preparation and fabrication of the materials for reactor fuel are relatively straightforward and are quite similar to that for urania. Sintered pellets of thoria containing a few percent of $^{235}UO_2$ have been used to fuel three significant reactors. The exposure of one fuel load was completed without malperformance of the fuel material, and the other two are approximately half-way to goal exposure, with no failures to date. If thoria-base fuels must be recycled in order for their use to be economically attractive, remote reprocessing will be required because of the presence of radioactive daughters of ^{232}U. The formation of ^{232}U cannot be avoided and its separation is impractical. Experience with the Kilorod Facility in fabrication of about 1000 fuel rods containing $ThO_2-^{233}UO_2$ fuel for lattice physics studies has been encouraging. Vibrational compaction of thoria–urania powder produced by the sol-gel process has been shown to

be an excellent method for remote reprocessing. A reprocessing plant has been designed for ORNL and is scheduled for completion of construction in 1967. In addition, an Italian plant for reprocessing thoria-base fuels will be completed this year and will, for its first job, reprocess Elk River Reactor fuel. This plant produces sintered pellet fuel from coprecipitated and calcined oxalates of thorium and uranium. With these plants in place and operational, the question of the practicality of recycle of thoria-base fuels should be resolved in a few years. Irradiation testing experience with sintered pellets and with vibrationally compacted powders of thoria–urania fuels has been excellent to date. High power, high exposure experience has been very limited so far but testing work recently completed by ORNL, or in progress now, will help to fill this gap. Only rod elements have been tested. In summary, there appear to be no technical barriers to the use of thoria–urania compositions in reactor fuel elements under modest power and exposure conditions. Fabricability has been demonstrated and the available data, although limited in extent, indicate that the physical and mechanical performance in the reactor will be at least as good as that of uranium dioxide fuels. In the absence of performance data at high power and high exposure, use of thoria–urania fuels under these conditions should be preceded by a demonstration test program. (auth)

13885 (IITRI-B6021-4) VANADIUM ALLOY STUDIES. Bimonthly Report, August 1–September 30, 1964. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract NOw-64-0239-c. 9p. $1.00 (OTS).

A vanadium alloy development program is being conducted for the purpose of producing improved short-time creep properties in the temperature range of 2200–2400°F. At present, the composition V–40Nb–30Ta–1Ti represents the material having the best creep properties without sacrificing fabricability or coatability; on the basis of creep strain over a 2-hr period at 2200°F, this composition is an order of magnitude better than any of the previously evaluated vanadium alloys. Work on the modification of this composition using a variety of approaches to produce a stable, high-strength particle dispersion is continuing. (auth)

13886 (LA-3208-MS) QUARTERLY STATUS REPORT ON PLUTONIUM REACTOR FUEL DEVELOPMENT FOR PERIOD ENDING NOVEMBER 20, 1964. (Los Alamos Scientific Lab., N. Mex.). Dec. 1964. Contract W-7405-eng-36. 20p. Dep.; $1.00(OTS).

Evaluation of fuels in LAMPRE Core II is summarized. Information is included on: iron–plutonium and cerium–cobalt–plutonium alloy fuels, fuel containment studies, fuel container fabrication, design and construction of Omega West Reactor Experiment, computer codes, development of Fast Reactor Core Test Facility, self-diffusion in plutonium, phase studies of americium–plutonium and plutonium–scandium alloys, and compositional control of LAMPRE fuel. (N.W.R.)

13887 (ML-TDR-64-110) RAW MATERIALS FOR REFRACTORY OXIDE CERAMICS. Hayne Palmour, III, Jerry M. Waller, R. Douglas McBrayer, Dong M. Choi, and Lawrence D. Barnes (North Carolina State Coll., Raleigh). Jan. 1964. Contracts AF33(616)-7288 and AF33(657)-8741. 484p. (AD-605804). $7.85(OTS).

Data are presented on the availability and consumption of raw materials for refractory oxide ceramics. The data are based on detailed surveys of commercial suppliers and consumers. About 410 individual raw materials and their properties are described; they include 39 oxide systems. (D.L.C.)

13888 (ML-TDR-64-227) OXIDATION RESISTANT HIGH TEMPERATURE PROTECTIVE COATINGS FOR TUNGSTEN. H. J. Nolting and R. A. Jefferys (Thompson Ramo Wooldridge Inc. TRW Electromechanical Div., Cleveland). July 1964. Contract AF33(657)-11151. 126p. (AD-607510). $2.00(OTS).

A controlled process was established for application of (silicon-tungsten) and titanium + zirconium + (silicon-tungsten) coatings to tungsten sheet. Protective capabilities of these coatings on arc cast and powder product tungsten sheet were determined at one atmosphere (air) from 1600 to 3600°F under cyclic conditions. Exposure at static pressures below 15 mm Hg (air) at 3400–3500°F resulted in varying degrees of deterioration of the (silicon-tungsten) and titanium + zirconium + (silicon-tungsten) coatings. Under dynamic low pressure conditions (2000-2800 ft/sec simulated air flow) at 16-20 mm Hg both coatings were protective to tungsten and resisted erosion in the temperature range of 2900-3400°F (180 to 325 $Btu/ft^2/sec$ heat flux range). Various refractory compound mixtures plasma sprayed on tungsten sheet were not protective at elevated temperatures in air. A silicon-tungsten + titanium nitride-boron nitride coating combination protected tungsten for short periods of time at 3700°F. Tensile properties were determined for silicon-tungsten and titanium + zirconium + (silicon-tungsten) coated arc cast tungsten sheet at various temperatures to 3300°F. In stress oxidation tests the same systems loaded at 20 percent of the yield strength showed essentially no creep after 1 hour at 3350°F in air. The coatings were completely protective at this stress level. (auth)

13889 (MLM-1208) REACTOR FUELS AND MATERIALS DEVELOPMENT PLUTONIUM RESEARCH—APRIL–JUNE 1964. L. J. Wittenberg and G. R. Grove (Mound Lab., Miamisburg, Ohio). June 30, 1964. Contract AT(33-1)-Gen-53. 32p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The location of two ternary eutectics has been determined in the portion of the plutonium–cerium–nickel phase diagram containing less than 50 at. % Ni. Both eutectics are at nearly the same temperature, 440 ± 3°C. All of the phases in equilibrium at both ternary eutectics are solid solutions. In the plutonium-rich corner of the plutonium–cerium–iron ternary phase diagram, two peritectic reactions were identified. The phases in equilibrium at one peritectic (435°C) are $PuFe_2$, cerium solid solution and plutonium solid solution. The phases at the second peritectic (417°C) are plutonium solid solution, $PuFe_2$, and Pu_6Fe. Metallographic examination of a sample with a composition of 15 at. % Pu–55 at. % Ce–30 at. % Fe which was quenched at 666°C indicated the presence of an unidentified phase. The composition of the phase was not determined. Investigation of the plutonium–cadmium equilibria revealed the presence of one congruently melting compound, $PuCd_2$, and three incongruently melting compounds, $PuCd_4$, $PuCd_6$, and $PuCd_{11}$. A wide liquid miscibility gap extends from approximately 2 at. % Cd to the monotectic at 60 at. % Cd, with the monotectic reaction isotherm at 910°C. Quantities of 0.1 at. % Fe, Co, or Ni added to plutonium caused additional transformations in the 405–412°C temperature range which were readily detected by differential thermal analysis (DTA). Additions of 0.1 at. % Fe or Co to 96.55 at. % Pu–3.35 at. % Ga alloy caused additional transformations at 405°C and a lowering of the solidus and liquidus temperatures. The combined presence of 0.05 at. % Fe and 0.05 at. % Ni depressed the Pu–Fe eutectic temperature to 390°C for plutonium and to 395°C for the Pu–Ga alloy. Infrared pyrometry was successfully used in preliminary tests for high temperature DTA. The infrared detector controlled a radio-frequency generator so that a tantalum sample was heated and cooled in an evacuated chamber at programmed rates which varied from 1 to 10°C per minute. Initial measurements were made with a new thermal diffusivity apparatus on annealed and unannealed Armco iron from 300 to 1000°C. The measured density of the liquid 99 wt % Pu–1 wt % Ga alloy decreased from 16.160 g/cc at 682°C to 16.003 at 847°C. Like plutonium, this alloy expanded during the transformation from the liquid to solid state. The relationship between composition and liquid viscosity of plutonium–cerium alloys is being studied. The viscosity of a 40.8 at. % Ce alloy decreased from 6.28 centipoise at 723°C to 4.82 centipoise at 912°C. The viscosity changed little when the composition of the alloy was changed to 34.4 at. % cerium. The liquidus temperatures of the alloys, which were determined concurrently, were determined to be at 703 and 692°C for the 40.8 and the 34.4 at. % Ce alloys, respectively. A technique was devel-

oped for the metallographic preparation of high density plutonium dioxide microspheres. The technique permits a cross-section view of a sphere without the former problems of pits in the surface and rounded edges. (auth)

13890 (NASA-SP-5014) NASA CONTRIBUTIONS TO THE TECHNOLOGY OF INORGANIC COATINGS. Jerry D. Plunkett (Denver. Univ. Denver Research Inst.). 1964. 267p. $1.00(GPO).

This book reviews major NASA research on inorganic protective coatings for thermal protection and lubrication purposes. The coatings covered include thermophototropic coatings, thermal control coatings for space vehicles, solid lubrication coatings, thermal insulation coatings, and refractory metal oxidation-resistant coatings. Methods of applying coatings to substrates and measurement of optical properties are also discussed. (D.L.C.)

13891 (NLCO-940) SUMMARY TECHNICAL REPORT FOR THE PERIOD OCTOBER 1, 1964 TO DECEMBER 31, 1964. R. Burgett, ed. (National Lead Co. of Ohio, Cincinnati). Feb. 10, 1965. Contract AT(30-1)-1156. 43p. Dep.; $3.00(OTS).

Eight papers are included which treat various topics related to the fabrication and properties of U. These topics include: reduction of UF_4 to metal in furnace pot, casting of Mark VB outer fuel cores, machining of U, separation of rare earths from U, electrodes for spectrographic analysis of U_3O_8, transformation temperatures of slightly alloyed U, and grain reflectance measurement. (D.L.C.)

For abstracts of individual papers see: 13202, 13528, 13892, 13944, 13945, 13946, 13993, and 13994.

13892 (NLCO-940(p.1.1-4)) THE DEVELOPMENT OF A LARGER FURNACE POT FOR THE REDUCTION OF UF_4 TO URANIUM METAL. E. W. Mautz, D. C. Bonfer, and J. L. Gindlesperger (National Lead Co. of Ohio, Cincinnati).

A 20-inch furnace pot for the production of uranium derbies has been tested with full-scale prototype equipment. This furnace pot was designed to provide a 50% increase in the weight of each derby but to still retain the present 12-inch derby diameter. (auth)

13893 (NMI-2134) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for the Month of November 1964. (Nuclear Metals. Div. of Textron Inc., West Concord, Mass.). Jan. 25, 1965. Contract AT(30-1)-2784. 27p. (NYO-2784-5). Dep.(mn); $2.00(cy), 1(mn) OTS.

Effort continues to be concentrated on the establishment of extrusion and drawing steps for tungsten–25 wt % rhenium tubing of two sizes: $\frac{1}{4}$-in. OD × 20-mil wall and 80-mil OD × 8-mil wall. Unsatisfactory tubing was obtained in two attempts to re-extrude tubing that had been drawn and annealed. Both tamped and pre-extruded CaC_2 were tried for the central filler. Work on drawing had to be confined to the larger tubing. A length subjected to a recrystallization anneal showed no improvement in either a plug draw or a moving-mandrel draw. Effort is being devoted to improvement of the smoothness of tubing used for drawing. Electropolishing is being tried. Results of hardness and density determinations on powder metallurgy extrusion sleeves are given. Results of ring compression tests on extruded tubing are presented. No significant change was noted in deformation behavior of beryllium crystals when scavenging of interstitials was attempted with 1000 ppm of titanium. The only assessment of the purity level attained in beryllium crystal L-6DD is a resistance ratio measurement. An analysis of the purity of crystal L-6DD is to be made by mass spectrography in an effort to establish the interstitial level and to confirm the indicated low level of metallics. (N.W.R.)

13894 (NP-14677) MACROLAMINATE PARTICLE COMPOSITE MATERIAL DEVELOPMENT. Interim Report No. 4, October 1–December 1, 1964. F. H. Simpson and L. M. Stejskal (Boeing Co. Aero-Space Div., Seattle). Contract NOw 64-0194-f. 36p.

Flexural, compressive, and oxidation tests were completed on specimens made from laminate sheets with dimensional and compositional variations. Flexural strengths varied between 27.5 and 80 ksi, compressive strength varied from 93.4 to 156.2 ksi, compressive deformation varied from 5.4 to 14.3 percent and weight loss due to oxidation at 2500°F after 24 hours varied from 232 to 943 mg/cm^2. Flexural strength of the composite increases rapidly when layers in the laminate particles are less than 0.001 in. thick. In general, compressive deformation increases with increasing metal content while compressive strength and oxidation resistance decrease. Properties of the composites were found to vary more due to the mechanics of the knife coating operation than to the variables of layer thickness and metal to ceramic ratio at layer thickness greater than 0.001 in. Variations in the ceramic microstructure and the differences in firing shrinkage between the metal and ceramic layers are producing the wide variations in properties. Changes in both of these appear to be due to variations in the concentration of the acrylic binder and magnesium oxide and to differences in the packing of the powder during the painting of laminate sheets. Hot and isostatic pressing of the composite was studied. An analysis of a Greco latin design experiment to study sintering parameters showed the strength of the composite structure is significantly affected by heating rate and time at maximum temperature while there was insufficient evidence to show the maximum temperature or cooling rate are significant within the limits of the experiment. Density was found to be significantly affected by time at temperature and maximum temperature, while heating and cooling rates had little effect. (auth)

13895 (NP-14783) BERYLLIUM: SURFACE TREATMENT AND COATINGS. Technical Report No. 329. W. W. Beaver and A. J. Stonehouse (Brush Beryllium Co., Cleveland). Aug. 1963. 33p.

The beryllium surface is quite important in determining the success or failure of the metal in actual service. Where mechanical properties are of prime importance, such as in structural components, surface treatments comprised of annealing or etching or combinations of both of these treatments should be applied to remove the damaged surface layers which arise from either machining or working operations. A large number of metals may be successfully electroplated on beryllium and generally provide a surface with properties of the electroplated metal. Anodizing appears extremely attractive as a finishing procedure for beryllium metal where corrosion is important. This protection applies to both high-temperature gaseous environments and to the corrosion of precision parts under more normal atmospheric exposure conditions. (auth)

13896 (NUMEC-2389-4) DEVELOPMENT OF PLUTONIUM-BEARING FUEL MATERIALS. Progress Report, January 1–March 31, 1964. (Nuclear Materials and Equipment Corp., Apollo, Penna.). Contract AT(30-1)-2389. 66p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A variety of plutonium dioxide and UO_2–PuO_2 feed materials was prepared for sintering studies, physical property measurements, and fabrication of irradiation test specimens. Additional processing details were evaluated, and improved control of impurity pickup during hammermilling was attained. Reslurry washing for removal of ionic residuals from freshly prepared plutonium oxalate was studied. While this technique is a process convenience, powder of inferior sinterability results. Additional powder blending studies were performed for the preparation of homogeneous feed material as an alternate to coprecipitated feed. Homogeneity is then determined by means of autoradiography of pressed and sintered pellets. The results indicate that the fine-scale homogeneity obtained by hammermilling of twin-shell blended powders is not improved by repeated cycles of blending and hammermilling. Additional work was performed on techniques for the determination of oxygen-to-metal ratio in UO_2–PuO_2 mixed oxides. The first of these is based on the change in weight when the sample is hydrogen reduced to definite stoichiometric composition. The effect of reduction temperature, time, and atmosphere on reference stoichiometry was evaluated. The second method utilizes controlled potential

coulometry for determination of the Pu-III/Pu-IV ratio. Thus, this method provides a direct measurement of the reduced phase Pu_2O_3. Metallography on pressed and sintered pellets formed from high-fired PuO_2 spheres in a UO_2 matrix revealed an extensive void had formed around each PuO_2 particle which effectively blocks inter-diffusion. A possible explanation is that UO_3 forms by reduction of the PuO_2 and vaporizes away from the PuO_2-UO_2 interface, thus forming the void. Oxygen diffusion constants and oxidation rate parameters were determined for UO_2-PuO_2 powders in sintered pellets ranging in composition from 5 to 35 wt % PuO_2. The effect of oxidation parameters on subsequent oxygen pickup was evaluated as a function of plutonia content. Thermal expansion data to 1250°C were determined for UO_2-PuO_2 specimens by means of high temperature x-ray diffraction. A nonreactive internal thoria standard was used for calibration. The coefficient of thermal expansion first increases and then decreases with increasing PuO_2 content. All pelletized fuel material for the high exposure radiation tests was fabricated. For the short-term irradiation testing program, the remaining capsules were irradiated. Three of the capsules were cut open and the contained fuel elements showed no increase in physical dimensions or change in appearance. (auth)

13897 (ORNL-TM-1052) A SURVEY OF THE LITERATURE ON HYDRATED ACTINIDE OXIDE SOLS AND U(IV) AND U(VI) HYDROLYSIS REACTIONS. D. M. Helton (Oak Ridge National Lab., Tenn.). Feb. 5, 1965. Contract W-7405-eng-26. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

This bibliography covers the following topics: (a) all available data relating to the preparation and applications of sols of hydrated actinide oxides as nuclear fuels; and (b) uranium(IV) and uranium(VI) hydrolysis reactions. The bibliography was compiled from a search of project literature, patents, and Chemical Abstracts through June, 1964. The entries are cross-referenced and are listed alphabetically by author. Patents are listed under the name of the issuing country. Journal abstracts of articles, when available, are used in the annotations. Author and subject indexes are given. (auth)

13898 (RFP-490) CERAMICS—RESEARCH AND DEVELOPMENT. Quarterly Progress Report, July–September 1964. D. J. Kessel (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Dec. 23, 1964. Contract AT (29-1)-1106. 18p. Dep.; $0.50(OTS).

The fabrication of ceramic crucibles and parts by powder metallurgy techniques is reported. Information is given on hot-pressing aluminum nitride crucibles, sintering cerium oxides, and spray-drying and hot-pressing alumina, magnesia, zirconia, zirconium silicates, and magnesium aluminates. (N.W.R.)

13899 (SC-R-65-852) INTERFACE FORMATION AND THE ADHESION OF DEPOSITED THIN FILMS. D. M. Mattox (Sandia Corp., Albuquerque, N. Mex.). Jan. 1965. Contract AT(29-1)-789. 19p. Dep.; $1.00(OTS).

A discussion is given of the types of interfacial regions which may be formed between a film and a substrate. Various deposition techniques are compared as to their ability to form the various types of interfacial regions. The mechanism of failure of the bond between film and substrate is discussed in terms of the type and structure of the interfacial region. The reasons for poor adhesion are discussed and approaches for overcoming adhesion problems are presented. The deposition process of "ion plating" is presented as one technique for overcoming many adhesion problems. (auth)

13900 (SWRI-1228-54) EVALUATION OF THE SERVICEABILITY OF THE ELK RIVER REACTOR PRESSURE VESSEL. Progress Report No. 9, October 1–November 30, 1964. José McDonald, Jr. and Paul D. Watson (Southwest Research Inst., San Antonio). Jan. 29, 1965. Contract AT(11-1)-1228. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The objective of the research program is to evaluate the serviceability of the ERR pressure vessel by determining the effects of fabrication procedures, irradiation, dissimilar weld metallurgy, and geometry on the fatigue life and nil ductility transition temperature. A302 Grade B steel specimens which were strained at 600°F and stress relieved to simulate the rolling operation were fatigue tested under constant-load low-cycle uniaxial conditions, and the results are presented. The dissimilar weld fatigue testing program and other phases of the research program are outlined. (D.L.C.)

13901 (TID-21415) RESEARCH ON GRAPHITE. Period Covered: April 1, 1964–March 31, 1965. P. L. Walker, Jr., H. B. Palmer, and W. S. Diethorn (Pennsylvania State Univ., University Park). Dec. 10, 1964. Contract AT(30-1)-1710. 64p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Development of a technique for making rate of formation measurements on thin C films is reported. Measurement of the thermoelectric power of purified compacted natural graphite at 300 to 725°K is also reported. Work on measuring the rate constants for the reaction of CO_2 with high-purity graphite was completed. Equations for the rate constant and reaction mechanisms are presented. Results of experiments on the reactivity of CO_2 with graphite are included in which the effects of additives were studied. Catalysis of graphite–CO_2 reactions using Co and Ni was studied. Studies of electric conductivity and thermoelectric properties of B-doped graphite are discussed along with the kinetics of graphite-oxygen reactions. Surface area measurements on molecular sieve carbons are reported along with those on Zeolite. Xenon sorption by C was determined in tracer studies. Work on the mechanisms of fission gas diffusion in graphite and on graphite irradiation and annealing is also reported. (J.R.D.)

13902 (TID-21624) A NEW APPROACH FOR THE EVALUATION OF SHRINKAGE DURING SINTERING. Technical Report No. XXVI. A. U. Daniels and M. E. Wadsworth (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Jan. 1, 1965. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 2176. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Difficulties inherent in the analysis of the sintering mechanism from shrinkage data for compacts arises from several sources. In the first place, geometric factors for ideal sintering are based upon spheres or some similar regular geometry when in fact the particles are irregular unless specially prepared. Also, the compact usually contains a fairly wide particle size distribution. Time of sintering is in error due to the heat-up period and time required for stabilization of the experimental equipment. The conventional analysis of sintering data requires a knowledge of the original length L_0 which in fact must be an ideal L_0 not actually measurable from the sample itself. The present treatment circumvents these difficulties by using only the data after some selected time t_s. The time t_s is selected after sintering has become ideal; i.e., gross irregularities in particle shape have been minimized by surface tension forces and initial sintering, and the temperature is uniform. Over this ideal region, usually beyond about 1% shrinkage and less than 6% shrinkage, ΔL and Δt measurements may be analyzed by means of a new sintering expression from which the mechanism, ideal L_0, and enthalpy may be calculated. (auth)

13903 (JPRS-27980) SAFETY ENGINEERING IN WORKING WITH BERYLLIUM. I. Ya. Yukhim. Translated from Metalloved. i Term. Obrabotka Metal., No. 11, 39-41 (Nov. 1964). 7p. (TT-64-51996). $1.00(OTS).

Some of the biological effects of beryllium are described. The safety measures used in the melting, powder-metallurgy, and laboratory experiments on the compounds of beryllium are reviewed. Cleaning of equipment is discussed. (D.L.C.)

13904 PRODUCTION OF NUCLEAR HAFNIUM BY THE VAN ARKEL PROCESS. N. Thien Chi, J. Vergnolle, and A. Remy (Compagnie Generale de Telegraphie Sans Fil, Puteaux, France). J. Nucl. Mater., 12: 310-18(1964). (In French)

Hafnium is always present in zirconium minerals and these two metals of nuclear interest have closely similar chemical properties. Consequently, the production of hafnium by the Van Arkel process is theoretically analogous

to that of zirconium and can be carried out in the same plant. A plant is described, which, with some modifications in the classical process applied to zirconium, allows production in a very narrow container of hafnium samples weighing 18 kg; an extreme weight of 23 kg can be attained. (auth)

13905 DEVELOPMENTS IN LITHIUM TECHNOLOGY. A REVIEW OF RIVAL DEMANDS IN INDUSTRY. M. Schofield (Wolverhampton and Staffordshire Coll. of Tech., Eng.). Metallurgia, 70: 278-80(Dec. 1964).

The occurrence and extraction of lithium are discussed, and its uses considered. (M.C.G.)

13906 A STUDY OF THE CONDITIONS FOR THE FORMATION OF AMALGAMS OF GADOLINIUM, TERBIUM, DYSPROSIUM AND HOLMIUM DURING ELECTROLYSIS ON A MERCURY CATHODE. V. P. Shvedov and P. G. Antonov. Radiokhimiya, 6: 581-5(1964). (In Russian)

The capacity of gadolinium, terbium, dysprosium, and holmium for amalgam formation was established by means of electrolysis, on a mercury cathode, of solutions containing the acetates of these elements and lithium citrate as a complexing agent. Basically the quantity of rare earth elements in the amalgam and in the electrolytic phase was determined by weighing the oxides obtained by the calcination of the precipitated hydroxides and oxalates. The error in the gravimetric analysis was ±0.5%, and in the radiometric analysis ±2–5%. The principal conditions of the experiment are summarized as follows: concentration of Gd, Tb, Dy, and Ho: 0.01 M; electrolytic volume: 15 ml; mercury volumes: 8 ml; current density: 30 ma/cm^2; cathode area: 20 cm^2; time of electrolysis: 2 hours. It was established that Gd, Tb, Dy, and Ho have the ability to form amalgams during the electrolysis of aqueous acetate-citrate solutions. The amalgamation of these substances depends to a marked extent on the concentration of lithium citrate and of the rare earth elements in the electrolyte. Optimum conditions for amalgam formation by these elements are presented. Rare earth amalgams were obtained with the following percentages by weight of mercury: Gd–0.15, Tb–0.075, Dy–0.055, and Ho–0.018. (TCO)

13907 REAKTORWERKSTOFFE. TEIL 1. METALLISCHE WERKSTOFFE. (Reactor Materials. Part I. Metallic Materials). Erich Gebhardt and Hans-Dieter Seghezzi. Stuttgart, B. G. Teubner Verlagsgesellschaft, 1964. 304p.

The general properties of the metals, the constitution of the most important alloy systems, and the special suitability of each metal or alloy for use in reactor construction are summarized. The metals considered are uranium, plutonium, thorium, zirconium, beryllium, niobium, stainless steel, aluminum, magnesium, hafnium, cadmium, and boron. Metallic coolants, the alloys, properties, corrosive effects, oxygen determinations, and liquid-metal cycles, are discussed in conclusion. (J.S.R.)

13908 DISPERSED URANIUM MONOCARBIDE–URANIUM NUCLEAR FUEL MATERIAL. Anthony John Mione. Thesis, Raleigh, N. C., North Carolina State Univ., 1964. 87p.

The factors affecting the production of a nuclear fuel material consisting of a fine, uniform dispersion of uranium monocarbide in a uranium metal matrix were determined. Initially, techniques were developed which largely eliminated oxidation of the pyrophoric powdered raw materials during processing. Specimens were then prepared both by the cold-pressing, vacuum-sintering and by vacuum hot-pressing techniques at temperatures between 980° and 1500°C. It was found that 10 to 15 percent of finely dispersed uranium dioxide was necessary to prevent excessive growth of the uranium monocarbide particles. Under certain processing conditions the surfaces of the individual particles of uranium metal became coated with a layer of oxide. During hot pressing, applied pressures of 3500 to 4000 psi caused the oxide films to rupture, and this permitted the molten metal to infiltrate between the uranium monocarbide grains. Specimens with the desired microstructure were produced only by hot pressing at temperatures between 1132°C (the melting point of uranium) and 1150°C for three minutes or less. Higher temperatures or longer times resulted in excessive uranium monocarbide particle growth, while satisfactory densification was not obtained at lower temperatures. The material developed consists of a uranium matrix with a dispersion of approximately 10^{10} uranium monocarbide and, to a lesser extent, uranium dioxide particles per cubic centimeter. This concentration should provide sufficient nucleation sites for fission product gases to make them collect in small bubbles and thus eliminate "swelling." (Dissertation Abstr., 25: No. 4, Oct. 1964)

13909 FABRICATION OF TUNGSTEN THERMIONIC EMITTER SURFACES BY CHEMICAL VAPOR DEPOSITION. Richard H. Singleton, Nolan D. McMurray, and Karl E. Muszar (General Motors Corp., Indianapolis). 10p. (CONF-640103-1)

From 7th Refractory Composites Group Meeting, Fort Worth, Tex.

The apparatus and process for chemical vapor deposition using WF_6 vapor are described. The effects of variables on the orientation, microhardness, and microstructure of the deposits were studied. The formation of free-standing structures and the joining of tungsten tubing by vapor deposition are discussed. (D.L.C.)

Corrosion

13910 (AECL-2085) HYDROGEN DISTRIBUTION IN OXIDIZED ZIRCONIUM ALLOYS BY AUTORADIOGRAPHY. C. Roy (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1964. 18p. Dep.; $1.00(AECL).

Tritium autoradiography provides a sensitive technique, complementing metallography, for studying hydrogen distribution. Specimens of zirconium alloys were encapsulated with carrier-free tritium, in the form of hydrogen gas or water, then held at controlled temperatures for predetermined times. Subsequent autoradiographs clearly mapped the hydrogen distribution and showed segregation even when a hydride phase was not readily observed metallographically. In the metal, the hydrogen was observed (under certain conditions) to be more heavily segregated at grain boundaries than in the bulk, even with samples quenched as rapidly as the method of preparation permitted. In oxides less than 1 micron thick grown in T_2O, an apparent grain-to-grain, correlation existed between the oxide thickness and the amount of hydrogen, thus suggesting a constant concentration in the oxide irrespective of substrate orientation. In pre-transition oxides preformed in oxygen and then treated in T_2O, the hydrogen distribution appeared uniform and the concentration exceeded that in their metal substrates by at least a factor of ten. Hydrogen segregation was apparent in post-transition oxides on Zircaloy-2. The substrates revealed high hydrogen absorption, which may be attributed to the high permeability of post-transition oxide. The solubility of gaseous hydrogen was found to be low in both oxide films and bulk ZrO_2. During oxidation, the solution of considerable oxygen in zirconium displaced hydrogen previously present in the surface region to a metal zone of lower oxygen content. The latter zone appeared to be enriched in hydrogen; this was attributed to a higher solubility in zirconium containing a concentration of ~4–8 at. % dissolved oxygen. (auth)

13911 (AECL-2118) THE BEHAVIOUR OF ZIRCONIUM ALLOYS IN SANTOWAX OM ORGANIC COOLANT AT HIGH TEMPERATURE. A. Sawatzky (Atomic Energy of Canada Ltd. Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). Oct. 1964. 47p. Dep.; $1.50 (AECL).

Zirconium alloys have been exposed to Santowax OM at temperatures of 320 to 400°C for times as long as 5000 hours. Short-term experiments (less than 2 weeks) were done in stainless-steel bombs and small out-of-pile loops. The X-7 organic loop in the NRX reactor was used to study long-term oxidation and hydriding both in-flux and out-of-flux. The results obtained lead to several tentative conclusions: (1) Aluminum cladding serves as an effective

hydrogen barrier. (2) Considerable protection against hydriding is given by zirconium oxide, provided impurities in the organic are carefully controlled. (3) Hydriding is greatly enhanced by the presence of chlorine in the coolant. (4) Hydriding is somewhat enhanced by neutron irradiation. Of considerable significance is the fact that a Zircaloy-4 in-reactor test section of the X-7 loop was exposed to Santowax OM at 320 to 400°C for more than 5000 hours without excessive hydriding. (auth)

13912 (AECL-2144) A STUDY OF OXIDE FILM BREAKDOWN ON ZIRCONIUM ALLOYS BY CAPACITANCE MEASUREMENTS. B. Cox and R. W. Ball (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1964. 27p. Dep.; $1.00(AECL).

Measurements of the impedance of oxide films on zirconium alloys versus the time after immersion in the electrolyte were used to determine the point of onset of oxide film breakdown during oxidation. The kinetics of the process which cause the change in capacitance during immersion of cracked or porous oxides may be related to the flow of electrolyte in the cracks or pores by capillarity. The kinetics change as one proceeds to higher oxide film thickness, and it may be possible to relate these effects to changes in the dimensions of the defects in the oxide. The absolute calibration of the method against defects of known size was not yet accomplished. (auth)

13913 (AFML-TR-64-327) FACTORS AFFECTING THE COMPATIBILITY OF LIQUID CESIUM WITH CONTAINMENT METALS. F. Tepper and J. Greer (MSA Research Corp., Callery, Penna.). Sept. 1964. Contract AF33(657)-9168. 41p. (AD-601237). $0.50(OTS).

Mechanisms associated with the corrosive attack of refractory metal alloys and superalloys by liquid cesium were investigated. The superalloys, Haynes-25 and TD-nickel, were exposed at 1800°F and the refractory metal systems, Mo–1/2Ti, Nb–1Zr, Ta–10W, and Nb–25Ta–12W–1/2Zr were exposed at 2100 and 2500°F. Pure nickel and pure zirconium were employed as dissimilar metal additions in some tests. Boiling reflux tests of each alloy candidate were performed. In the case of the refractory alloys, the boiling temperatures were 2100 and 2500°F, while 1800°F was the test temperature employed for Haynes-25 and TD-Nickel capsules. The Haynes-25 and the TD-Nickel show some dissolution in cesium, and a measurable amount was experienced by Mo–1/2Ti at 2500°F. The tantalum and niobium alloys show little in the way of cesium attack at 2100°F. Metal solubility studies showed the solubility of the refractory metals niobium and molybdenum to be approximately 10–20 ppm at 2500°F. Synergistic effects appear to control solubility in some cases. Dissimilar metal tests showed mass transfer of metallic elements to be experienced by all couples in the presence of pure liquid cesium except Mo–1/2 Ti/Zr. Interstitial elements also undergo mass transfer and carbon and/or oxygen additions so the cesium can effect significant changes in the behavior of couples. The solubility of carbon in cesium was determined between 600 and 1200°F and data were obtained showing no effect of carbon on the freezing point of cesium. (auth)

13914 (CONF-729-4) OXIDATION PROTECTION OF BERYLLIUM AT HIGH TEMPERATURES. Ray J. Van Thyne, John J. Rausch, Jacob M. Miller, and William S. Netter (Illinois Inst. of Tech., Chicago. IIT Research Inst.). [1963]. For Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif. Contract AT(11-1)-578. 31p. Dep.(mn); $2.00(cy), 1(mn) OTS.

From International Conference on Beryllium, Philadelphia, Oct. 1964.

The objective of this work was to improve the oxidation performance of beryllium neutron reflectors to simplify the ground testing of space nuclear power systems. Many coating systems including pack diffusion, enamel, composite, and spray coatings were investigated, but the most successful techniques developed to date were anodizing procedures and fused metallic slurry procedures. Anodized coatings about 0.0003 inch thick produced under a wide variety of conditions were similar in appearance; however, the high-temperature oxidation resistance varied considerably. Oxidation test results in air of different dew points and dilute oxygen–gas mixtures were used to develop improved anodizing conditions. Silicon–beryllium alloys were employed as surface coatings to protect beryllium because the alloys were sufficiently oxidation-resistant and silicon exhibits good diffusional stability with beryllium. Alloys containing 35 to 70 wt % silicon were arc melted, crushed to powder, applied as a slurry, and fused at temperatures of 2100 to 2150°F. The Be–Si alloys produced well-bonded, graded structures. Beryllium anodized by selected techniques is protected in 35°F dew point for over 200 hr. The fused Be–Si coatings offer potential of even greater resistance. Good diffusion stability was shown by these coating systems during exposure for times up to 2300 hr at 1350°F. Emittance of coated materials was determined. (D.L.C.)

13915 (NP-14771) ULTRASONIC-INDUCED CAVITATION STUDIES. Technical Report No. 1. R. Garcia and F. G. Hammitt (Michigan. Univ., Ann Arbor. Coll. of Engineering). Oct. 1964. 107p.

Various accelerated cavitation damage devices for laboratory testing programs are considered, and a vibratory device utilizing a piezoelectric crystal is found to be feasible for the studies planned. Test specimens of various materials are attached to the ultrasonic transducer and vibrated at a frequency of approximately 20 kc/sec and with a maximum amplitude of 2.75 mils. A severe cavitation cloud is produced in close proximity to the test specimen. This ultrasonic device has been tested and calibrated using fluids ranging from water to mercury, thus encompassing a wide range of fluid densities. Various test specimen materials have been subjected to the accelerated cavitation. The experimental program will include the systematic testing of 13 different materials in 3 fluids at various temperatures. The test materials are 1100-0 Al, 2024-T351 Al, 6061-T651 Al, 304 stainless steel, 1010 carbon steel, Cb–1Zr, Ta–8W–2Hf, Mo–½Ti, plexiglas, Cu, Cu–Zn, Cu–Ni, and Ni. The test fluids include water, mercury, and Pb–Bi. A high-temperature facility has been designed and built. (D.L.C.)

13916 (SAN-8002(p.189-209)) SODIUM MASS TRANSFER INVESTIGATIONS. R. W. Lockhart, L. E. Pohl, and R. S. Young (General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]).

Procedures and equipment for obtaining corrosion-test data for alloy samples in flowing Na are described. The Sodium Mass Transfer Loop is described. Experimental results on corrosion of 316 SS, Cr–Mo steel, and Cr–Mo-Ti steel are given. (T.F.H.)

13917 (SY-5463-R) MASS-TRANSFER TESTS WITH TWO-PHASE FLOW. E. A. Kovacevich and R. L. Salley (Garrett Corp. AiResearch Mfg. Div. of Arizona, Phoenix). Nov. 20, 1964. Contract AF33(657)-8954. 138p. (APL-TDR-64-119; AD-608565). $4.00(OTS).

A closed loop fabricated entirely from Nb–1.0 wt % Zr material was operated with potassium under dynamic two-phase (liquid and vapor) conditions. A test section containing orifices and Mo–0.5 wt % Ti test specimens was placed in the vapor stream. The maximum fluid temperature of 1950°F and the maximum vapor temperature of 2000°F were maintained throughout the test. Condensing occurred at 1770°F. The test was conducted for 307 hours of the scheduled 1,000 hours. The test was terminated due to a twisted ribbon failure in the boiler section, which resulted in a flow restriction. The test was conducted in a purified argon atmosphere and was monitored for impurities during the test. Despite the precautions taken to minimize contamination of the loop material, contamination of the refractory alloy existed. Under the test conditions, there was no evident corrosion and/or erosion of the loop materials. (auth)

13918 (WCAP-5368) CORROSION AND CORROSION PRODUCT BEHAVIOR IN CHEMICAL SHIM SOLUTIONS. G. R. Taylor and D. D. Whyte (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). [1962]. Contracts

AT(30-1)-3064 and AT(30-1)-3269. 28p. (CONF-492-8). Dep.(mn); $2.00(cy), 1(mn) OTS.

From National Association of Corrosion Engineers, Chicago, Mar. 1964.

Metal release rates from type 304 stainless steel exposed to high temperature boric acid and partially neutralized boric acid solutions were determined in a recirculating loop system by radiotracer techniques. Results indicate that initially the release rate is higher in the partially neutralized solution but that the rate decreases rapidly with exposure time. The net deposition rate on type 304 stainless steel was also determined for both chemistries with the rate being higher in the partially neutralized boric acid solution. The net deposition rate on various reactor structural materials and on preoxidized specimens of these materials is also given. Analyses of the ion-exchange resins used for both tests are included showing that the main action of the resins is ion-exchange and not filtering. (auth)

13919 THE PARABOLIC OXIDATION KINETICS OF BETA-ZIRCONIUM. C. J. Rosa and W. W. Smeltzer (McMaster Univ., Hamilton, Ont.). Acta Met., 13: 55-60 (Feb. 1965).

An investigation was made of the oxidation properties of β-zirconium at 950°C in oxygen for periods extending to 100 hr. The kinetics were determined by a volumetric technique and may be represented by a parabolic relationship after a period of rapid oxidation. The thicknesses of the zirconium dioxide scale and the underlying layer of α zirconium–oxygen solid solution were determined by metallographic techniques. Parabolic diffusion relationships derived from a three phase oxide-metal model account for the kinetics of oxidation, scale growth, and oxygen solution in the metal. (auth)

13920 OXIDE DISSOLUTION IN CORROSION OF ALUMINUM CLADDING ON NUCLEAR REACTOR FUEL ELEMENTS. D. R. Dickinson (Battelle Memorial Inst., Richland, Wash.). Corrosion, 21: 19-27(Jan. 1965).

The effect of aluminum oxide dissolution on aluminum corrosion in high-temperature deionized water is discussed. Such dissolution promotes corrosion by removing protective oxide and is especially significant in nonisothermal systems, such as aluminum-clad fuel elements in nuclear reactors cooled by pressurized water, where the water cannot be kept saturated with dissolved oxide. It is hypothesized that resistance to dissolution lies principally in mass transfer from oxide-water surface into bulk water. Dissolution rates could be estimated by use of general equations for mass transfer if oxide solubility was known as a function of temperature. Dissolution rates thus calculated were in good agreement with in-reactor corrosion rates of aluminum-clad fuel elements in high-temperature deionized water, which were previously measured at Hanford. Fair agreement was obtained with measurements in recirculating out-of-reactor loops. It was concluded that mass transfer of dissolved oxide into the water may be the principal factor controlling the corrosion rate of aluminum-clad fuel elements in many nuclear reactor systems using high-temperature pressurized deionized water as coolant. (auth)

13921 OPTICAL MEASUREMENT OF OXIDE FILMS ON ZIRCONIUM IN THE RANGE OF WAVELENGTHS FROM 2000 Å TO 2.5 μ. N. J. M. Wilkins (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Corrosion Sci., 5: 3-18(Jan. 1965). (AERE-R-4666)

Spectrophometric measurement of optical interference provided a convenient nondestructive measurement of the oxide film thickness on selected areas of a zirconium specimen, and should be capable of accurate measurement over a wide range of film thickness, if a good calibration of the interference/thickness relation is available. The refractive index and phase difference due to reflection from the interfaces were determined for anodic oxide films on zirconium in the range of wavelength between 2000 Å and 2.5 μ. From these values an interference minima/film thickness graph was calculated, and a modification to the graph was included to allow for the effects of an absorption at 2290 Å in films formed by oxidation in steam and oxygen. The interference/thickness graph can be used to measure anodic, and some thermal, films up to 1 μ to an accuracy of ±1% in relative thickness and ±3.5% absolute thickness. For other thermal films, use of the interference method may be limited, due to absorption in the oxide and uneven film growth. (auth)

13922 PROTECTION OF URANIUM BY FLAME-SPRAYED METALLIC DEPOSITS. O. Flint (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Corrosion Sci., 5: 19-28(Jan. 1965).

Deposits of Mg, Fe, Cu, Zr, and Mo formed on uranium by flame-spraying techniques all failed on thermal testing in CO_2 at 500°C due to volume changes in the underlying oxide film, the inherent porosity of flame deposits, and differential expansion of the deposit and the uranium base. A short term, ten-hour, protection was found with Al deposits when annealed to form UAl_3, which might be used as insurance against undesirable consequences of a fuel element can failure. (auth)

13923 THE INFLUENCE OF CRYSTAL ORIENTATION ON THE OXIDATION OF TUNGSTEN. R. W. Bartlett and J. W. McCamont (Philco Research Labs., Newport Beach, Calif.). J. Electrochem. Soc., 112: 148-52(Feb. 1965).

The oxidation of tungsten above 1800°C is described in terms of deviations from gas collision theory (Hertz-Knudsen equation). The probability that a colliding oxygen molecule will react with tungsten is strongly dependent on crystal orientation. Of the crystal faces examined, (100) surfaces oxidize most rapidly with a reaction probability of 0.4 (111) and (110) surfaces oxidize at approximately the same rate as polycrystalline tungsten. The morphology of oxidized (100) surfaces is smooth with the exception of occasional stepped octahedral pyramids each bound by {111} faces. The morphology of (111) surfaces is smooth except for numerous stepped tetrahedral pyramids each bound by {100} faces. Initiation of these shapes is not associated with dislocations or detectable impurities. However, dislocations subsequently cluster at mature octahedral pyramids. The morphology of oxidized (110) tungsten surfaces consists of extremely irregular surfaces and macroscopic ledges, but shapes clearly related to crystal geometry were not identified. (auth)

13924 LOW-PRESSURE OXIDATION OF NIOBIUM AT 1200°-1700°C. Per Kofstad and Svein Espevik (Central Inst. for Industrial Research, Blindern, Oslo). J. Electrochem. Soc., 122: 153-60(Feb. 1965).

The oxidation behavior of niobium was studied at 1200-1700°C at oxygen pressures ranging from 2×10^{-4} to 0.5 Torr. The oxidation involves dissolution of oxygen in the metal, formation of NbO, NbO_2, and Nb_2O_5. The oxidation may be divided into 3 main stages: an initial linear oxidation is followed by a parabolic oxidation which, in turn, transforms into a final linear oxidation. The initial linear oxidation involves dissolution of oxygen in the metal and the oxidation is governed by the rate of chemisorption on the metal surface. The parabolic oxidation is due to formation of protective NbO_2, which is further oxidized to porous nonprotective Nb_2O_5 at a linear rate. The oxidation is affected by the presence of liquid Nb_2O_5 at and above 1500°C, and at higher temperatures evaporation of Nb_2O_5 becomes an increasingly important part-process. (auth)

13925 THE DEVELOPMENT AND PROPERTIES OF AN OXIDATION-RESISTANT COATING FOR URANIUM. J. H. Buddery, M. E. Clark, R. J. Pearce, and J. J. Stobbs (Central Electricity Generating Board, Berkeley, Gloucestershire, Eng.). J. Nucl. Mater., 13: 169-81(1964).

Work is described on the development of a uranium alloy coating design to protect uranium fuel bars from oxidation in the event of carbon dioxide leakage into a can in a uranium-Magnox type of reactor. Eleven possible elements (Cu, Mn, Al, Fe, Ni, Ti, Zr, Nb, Mo, V, and Cr) were initially selected for alloying. Further selection, by oxidizing cross sections of diffusion couples, revealed the best system to be the one involving aluminum, in particular the intermetallic compound UAl_3. Subsequently coatings of

UAl_3 were prepared on small laboratory test specimens by a pack-aluminizing method and were found to delay the onset of the rapid oxidation occurring with uncoated uranium for ~400 hours in static and ~100 hours in flowing carbon dioxide at 450°C. In addition the coatings appeared to possess suitable mechanical properties, can be applied at a convenient temperature, are compatible with Magnox, do not diffuse into uranium, have an acceptable neutron capture cross section, and seemed unlikely to affect heat transfer from a fuel element. (auth)

13926 THE TEMPERATURE DEPENDENCE OF THE CORROSION OF URANIUM IN AQUEOUS SOLUTIONS. J. S. Llewelyn Leach and A. Y. Nehru (Imperial Coll. of Science and Tech., London). J. Nucl. Mater., 13: 270-4(1964).

Investigations of uranium corrosion in acidic solutions showed that both cathodic polarization and additions of zirconium led to increases in diffusion rates within the protective oxides formed on the metal. The behavior in alkaline solutions was more complicated. Studies were made to determine whether the observed changes in corrosion rate caused by altering the experimental conditions are temperature independent or whether they could correspond to changes in the activation energy for growth of the oxide. The results obtained were interpreted as showing that changes in corrosion behavior are associated with changes in the activation energy of the process, and, in addition, suggest a relationship between the electronic and ionic conductivities of the oxides formed during aqueous corrosion. (M.C.G.)

13927 THE EFFECT OF OXIDATION ON THE COMPRESSIVE STRENGTH OF GRAPHITE. A. C. Collins (Central Electricity Generating Board, Leatherhead, Surrey, Eng.), H. G. Masterson, and P. P. Jennings. J. Nucl. Mater., 15: 135-6(1965).

An examination of the dependence of compressive strength of graphite was undertaken to determine how far the process of oxidation and pore enlargement could proceed before the minimum safe limit of graphite strength was reached. The compressive strength was found to decrease rapidly with increasing oxidation, reaching half the original value at about 10% weight loss. There was no apparent difference in compressive strength between samples cut perpendicular and parallel to the direction of extrusion. Up to 20% weight loss, the specimens generally failed by diagonal shearing, but above this burn-off level, they disintegrated quickly under compression to a fine powder. (M.C.G.)

13928 METALLOGRAPHIC EXPLANATIONS OF STRESS CORROSION CRACKING DAMAGE TO FERRITIC AND AUSTENITIC STEELS. Hans Keller and Grete Petrich (Farbwerke Hoechst, Frankfurt am Main). Prakt. Metallog., 1: 66-72(June 1964). (In German)

Conditions leading to stress corrosion cracking are described and possibilities of this corrosion are outlined. After describing the metallographic investigation, some damages typical in the chemical industry are discussed in greater detail. Arrangements made to stop further damages are emphasized. (auth)

13929 OXIDATION KINETICS OF HIGH MELTING ALLOYS. NIOBIUM–NICKEL AND NIOBIUM–ALUMINUM ALLOYS. R. F. Voitovich. Zh. Fiz. Khim., 38: 2954-7 (Dec. 1964). (In Russian)

Kinetics of the high-temperature oxidation of Nb alloyed with Ni and Al were studied at 500 to 900°C. Alloying with Ni and Al increase Nb heat resistance at all examined temperatures. (R.V.J.)

13930 VYSOKOTEMPERATURNOE OKISLENIE METALLOV I SPLAVOV. (High-Temperature Oxidation of Metals and Alloys). I. N. Frantsevich, R. F. Voitovich, and V. A. Lavrenko. Kiev, State Publishing House of Technical Literature in Ukrainian SSR, 1963. 324p.

An analysis was made of high-temperature oxidation processes in metals and alloys considering the concepts of solid-state physics and chemical lattice defects. A survey was made of cinder formation in high-melt metals and of various types of anticorrosion coatings and methods for their deposition. (R.V.J.)

13931 CORROSION OF ZIRCONIUM ALLOYS. A Symposium Presented at the 1963 Winter Meeting [of] American Nuclear Society, New York, N. Y., November 20, 1963. (American Society for Testing and Materials, Philadelphia). ASTM Special Technical Publication No. 368. 1964. 142p. $7.00.

Seven articles are included; one was abstracted separately in NSA. The remaining 6 articles were previously abstracted in NSA as 17: 27729 and 18: 10469, 12589, 14480, 14744, and 18284. (P.C.H.)

For an abstract of individual paper see: 13932.

13932 ZIRCALOY-2 CORROSION IN-PILE IN AQUEOUS HOMOGENEOUS REACTOR SOLUTIONS. G. H. Jenks (Oak Ridge National Lab., Tenn.). p.41-57 of "Corrosion of Zirconium Alloys. ASTM Special Technical Publication No. 368." Philadelphia, American Society for Testing and Materials, 1964. (CONF-187-85).

A correlation and analysis of many of the data obtained at Oak Ridge National Laboratory (ORNL) for the in-pile corrosion of Zircaloy-2 in oxygenated uranyl sulfate solutions is described. The data were obtained in a program of in-pile loop and autoclave experiments in which a variety of solution compositions, solution velocities, fission power densities, and temperatures were tested. The experiments had the objective of obtaining information that would enable the prediction and control of corrosion in homogeneous reactors. The correlations were based on the following equation for the relationship between corrosion rate, R (mil per year), and fission power density in solution, P(w per ml), $1/R = K_1/KP\alpha + 1/K$, where α is a factor by which the effective power density at a corroding surface is greater than that in solution, owing to uranium sorption on the surface; K_1 and K are other factors evaluated from the data. A semi-empirical model for the radiation effects on the corrosion, which leads to this equation, is described. A brief review of experimental method and results is also given. Considerations of the experimental corrosion data at 280°C and of probable relative and absolute values of α led to the conclusions that a relationship of the above form was obeyed up to the highest power density tested (110 w per ml), and that the values of K and K_1/K were essentially independent of changes in solution composition. On the bases of the reasonable assumptions that the general relationship, with K and K_1/K independent of solution composition, was obeyed at other temperatures, and that the values of α in certain experiments did not change appreciably with change in temperature, it was concluded that over the temperature range investigated (225 to 330°C) the data obtained in all experiments were reasonably well represented by the equation: $1/R = 2.3/P\alpha + 1.3 \times 10^{-11} \exp(11{,}500/T)$. The value of α is dependent upon solution composition and velocity, and values ranging from unity to about 14 were observed. Conditions under which values of α near unity can be maintained in a reactor can be estimated from the results. (auth)

Fabrication

Refer also to abstracts 13538 and 14846.

13933 (AD-422935) INVESTIGATION OF ULTRASONIC WELDING OF REFRACTORY METALS AND ALLOYS. Bimonthly Progress Report No. 6, June 16, 1963–August 15, 1963. (Aeroprojects, Inc., West Chester, Penna.). Sept. 1963. Contract NOw 63-0125-c. 20p. $2.60(OTS).

Ultrasonic welds in Inconel X-750 and in molybdenum–0.5% titanium alloy produced with power-force programming showed significantly higher strengths than those made with conventional power and force application. Metallographic examination of the molybdenum alloy welds revealed superior bonding. (auth)

13934 (AD-608190) DEVELOPMENT OF VERY HIGH STRENGTH BERYLLIUM WIRE. Bimonthly Report No. 5,

August 6, 1964–October 6, 1964. Technical Report No. 374-243. E. A. Murphy and R. G. O'Rourke (Brush Beryllium Co., Cleveland). Oct. 22, 1964. Contract NOw 64-0162-c. 16p. $1.00(OTS).

Results of work directed toward development of a process to produce high-strength beryllium fine wire are described. Material chemistry for the 5% and 2% copper–beryllium alloys is listed. The material of Group 3f, SOV-68, showed a definite increase in drawability over the other fine-grained materials. The evaluation of the SOV-68 hard-drawn wire that received its last anneal at 0.210-inch diameter showed a 15% increase in tensile strength with a substantial increase in wire ductility at 0.00477-inch diameter size over any previously reported data. (auth)

13935 (ANL-6924) THE NONDESTRUCTIVE TESTING OF BRAZED JOINTS. Akira Kannō (Argonne National Lab., Ill.). Nov. 1964. Contract W-31-109-eng-38. 30p. Dep.; $2.00(OTS).

A comparative study was made of three nondestructive testing methods: x-ray radiography, neutron radiography, and ultrasonic testing. Brazed joints with a clearance of 0.0254 mm were made using ASTM 304 stainless steel and ASTM 4023 steel as base metals, and Nicrobraze, Easy Flow 35 and BAg8 as brazing alloys, and standard brazing faults were introduced by means of holes in brazing-alloy foils. The unsharpness of x-ray and neutron radiography was studied. Ultrasonic methods were found to have superior sensitivity to nonbonds in diffusion-bonded samples, but resolution is poor. The Gd-M direct neutron radiography method is recommended for faults in thermal-neutron-sensitive brazing alloys. (D.L.C.)

13936 (CONF-729-2) SOLID-STATE BONDING OF BERYLLIUM. Edwin S. Hodge, Paul J. Gripshover, and Hugh D. Hanes (Battelle Memorial Inst., Columbus, Ohio). [1963]. Contract W-7405-eng-92. 10p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

From International Conference on Beryllium, Philadelphia, Oct. 1964.

Gas-pressure bonding was studied as a technique for self-bonding of beryllium without diffusion aids. Chemical milling, mechanical abrasion, machining, cold rolling, and grit blasting were investigated as surface-preparation techniques. These surface treatments were studied with specimens bonding at temperatures ranging from 1550 to 1850°F. Grit blasting with chilled iron grit followed by washing the surfaces in dilute nitric acid to remove embedded grit was shown to be the optimum surface preparation. Bonding for 4 hr at 10,000 psi and 1650°F or higher provided parent-material strength. For example, hot-pressed beryllium rods butt bonded at optimum conditions fractured in the parent material at an ultimate tensile strength of 36,400 psi. Structural members, such as nuclear fuel elements, box- and I-beams, and truss-supported members have been fabricated from wrought sheet components. These structures were formed by supporting the beryllium members with internal tooling which was removed after bonding by selective leaching. Iron was chosen as a tooling material, and potential barriers to eliminate iron-to-beryllium reaction were investigated. Molybdenum, graphite, and BeO appeared promising as diffusion barriers. The over-all results indicated good potential for gas-pressure bonding as a technique for joining beryllium for structural applications. (D.L.C.)

13937 (DMIC-208(Vol.I)) METAL DEFORMATION PROCESSING. VOLUME I. A SURVEY CONDUCTED AS PART OF THE METAL-WORKING PROCESS AND EQUIPMENT PROGRAM (MPEP). F. W. Boulger, W. M. Baldwin, Jr., A. H. Clauer, J. A. Houck, M. J. Klein, H. R. Ogden, C. N. Reid, A. R. Rosenfield, A. M. Sabroff, and D. E. Strohecker (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 14, 1964. Contract AF33(625)-1121. 127p. (AD-608637). $4.00(OTS).

A survey was conducted to collect and summarize information on deformation characteristics of metals and their effect on processing operations. The information was obtained from reports on Government-sponsored work and from articles in technical publications. Eight subjects are covered: extrusion, forging, rolling, thermal mechanical variables affecting the properties of refractory metals and alloys, development of preferred orientations, anisotropy of strength and ductility, high-strain-rate deformation, and strain aging. Generalized discussions of common processes point out why specific variables must be modified in order to deform certain types of metals satisfactorily. When practical, data on the more-difficult-to-form metals are used to illustrate the principles, limitations, and effects of the processes. (D.L.C.)

13938 (EUR-2158.f) RÉALISATION DE CRAYONS COMBUSTIBLES EN CARBURE D'URANIUM GAINÉ DE SAP POUR IRRADIATION DANS LE RÉACTEUR NRX EXPÉRIENCE NRX 716. (Fabrication of Uranium Carbide Fuel Rods Canned with SAP for Irradiation in the NRX Reactor—Experiment NRX 716). R. Klersy, G. Musso, G. Detiffe, and J. P. Lecoq (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 73p. Dep.(mn).

A description is given of the fabrication of a number of fuel rods for irradiation tests. Preliminary testing of the materials used and testing of finished fuel elements are covered. (auth)

13939 (EURAEC-1097) A STUDY ON RESIDUAL STRESSES GENERATED BY THE UPWARD VERTICAL WELDING PROCESS. Quarterly Reports No. 10 and No. 11, April 1–September 30, 1964. (Arcos, S. A., Brussels). Work Performed under United States–Euratom Joint Research and Development Program. Contract 053-61-12-RDB. 103p. (EURAEC-1214). Dep.(mn); $4.00(cy), 2 (mn) OTS.

Drilling, calibrating, and cutting operations on a 100-mm-thick sheet plate are evaluated. After stress relieving cuttings, the sections containing the thermocouples were withdrawn to measure the exact distances from the fusion line. This enabled the usual temperature measurements. Penetration was checked on the same cuttings. Surface stresses were determined. Deep stresses were determined by the triaxial drilling method. The Mathar-Soete-Vancrombrugge method for measuring deep stresses in the neighborhood of the surface was applied on each face of the weld seam. As these stresses presented some variations not easily explained, two tests were made without stresses, one on a stress-relieved sheet plate and the other on a piece subjected to a known stress. The temperature gradient is determined on a 100-mm-thick sheet plate. A new method for determining the stresses at the surface was proposed and tested in order to compare results obtained by Mathar's method. (N.W.R.)

13940 (EURAEC-1242) ELECTRO-SLAG WELDING OF REACTOR STEELS. Quarterly Report No. 14, July 1–September 30, 1964. (Schweisstechnische Lehr-und Versuchsanstalt, Duisburg, Germany). Oct. 21, 1964. Work Performed under United States–Euratom Joint Research and Development Program. 93p. Dep.(mn); $3.00(cy), 2(mn) OTS.

On completion of heat treatment, welded joints effected with a Mn–Ni–Mo filler rod on ASTM 302 Grade B steel sheets and with a Cr–Ni–Mo rod on 13 CrMo 44 steel sheets showed high, and in some cases unprecedentedly high, notch impact strength values. A further check was made to determine the effect of welding under argon on the strength properties. An orientation test demonstrated the beneficial influence of a local heat treatment carried out with preheating torches directly after the welding process on the notch impact strength values in the weld seam. Welded joints on a number of flat sheets showed that a judicious combination of welding parameters such as voltage, current, electrode oscillation speed, and cooling can lead to a considerable improvement in the properties. The influence of the oscillation speed appears to be particularly important. The improved apparatus for the welding of completely closed circular seams was tested out by successful execution of two circular weld seams. (auth)

13941 (KAPL-3073) DEVELOPMENT OF A TRANSITION JOINT BETWEEN ZIRCALOY-4 AND Ni–Cr–Fe (ALLOY 600). G. E. Halm and E. O. Porter (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 2, 1964. Contract W-31-109-eng-52. 64p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A procedure was developed for making joints between Zircaloy-4 and Ni–Cr–Fe (Alloy 600), using the friction-welding process. When exposed to operating conditions not exceeding 1000°F, joints produced by this process exhibited tensile and fatigue properties equal to those of the Zircaloy base material; when subjected to bending or impact loads, however, the joints were not satisfactory because of lack of ductility. Nevertheless, they were considered adequate for the intended application since substantial mechanical support could be provided in the component design to prevent loading of the joints by bending or during impact. Five processes were investigated for making a joint of this type: friction welding, eutectic bonding, coextrusion, explosive bonding, and flash welding. Only the friction-welding process produced usable joints. The eutectic-bonding process produced joints that were too brittle to evaluate; these joints actually failed during cooling or sectioning for metallurgical examination. The coextrusion process produced satisfactory joints with two exceptions – reduced fatigue strength after exposure to 680°F ammoniated water and bond-layer cracking as revealed by metallurgical sectioning. The explosive-bonding process was not sufficiently developed to yield joints acceptable for mechanical testing. Flash welding produced joints with low ductility in bend-testing and with reduced tensile strength; this process was investigated only to a limited extent because of time limitations and progress made with other processes. (auth)

13942 (LA-3181) HIGH-DEFORMATION-RATE EXTRUSION OF THIN-WALLED TUNGSTEN HEMISPHERES. James M. Dickinson (Los Alamos Scientific Lab., N. Mex.). Aug. 1, 1964. Contract W-7405-eng-36. 17p. Dep.; $1.00(cy), 1(mn) CFSTI.

A method of producing a thin-walled tungsten hemisphere from a solid cylinder of tungsten in a single operation using a high-deformation-rate extrusion process was investigated, and the preliminary results indicated that the method was feasible. A tungsten carbide die coating was developed that successfully protected the die set from serious damage during the extrusion process. (auth)

13943 (NAA-SR-8887) URANIUM CARBIDE PROCESS DEVELOPMENT FOR THE ADVANCED SODIUM COOLED REACTOR. J. W. Carroll, D. H. Turner, and M. H. Binstock (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1965. Contract AT(11-1)-Gen-8. 28p. Dep.; $0.75(OTS).

Hypostoichiometric uranium monocarbide is the reference fuel for the Advanced Sodium Cooled Reactor (ASCR) concept. A process development program, for developing an economical UF_6 to UC fuel slug manufacturing process, including synthesis, slug fabrication, and scrap recovery, is described. The UC synthesis process, utilizing carbothermic reduction of UO_2, is described. Commercially synthesized UC melt stocks have been evaluated. Carbon compositional control, which is largely related to melt stock quality, is the major problem in large-scale UC slug-casting. Three alternate methods for process scrap recovery are described. (auth)

13944 (NLCO-940(p.2.1-5)) CENTRIFUGAL CASTING OF MARK VB OUTER FUEL CORES. R. J. Lusky (National Lead Co. of Ohio, Cincinnati).

Centrifugally cast Mark VB outer fuel cores were produced in a mold 3¼ inches in ID. The cast iron molds were coated with a zircon-based wash. An improved gas-air preheater for curing the coating and heating the mold was designed. Factors which affect the bore taper of the cast tube were investigated. (auth)

13945 (NLCO-940(p.3.1-8)) STATIC CASTING OF MARK VB OUTER FUEL CORES. R. J. Lusky and H. M. Eikenberry (National Lead Co. of Ohio, Cincinnati).

Mark VB outer fuel cores were produced by a static-casting technique using a refractory-coated mold. The mold, which was designed with nine cavities around the periphery, produced tubes 38 inches long. These tubes could then be machined into the finished fuel cores. (auth)

13946 (NLCO-940(p.4.1-7)) EVALUATION OF CARBIDE CUTTING TOOLS FOR MACHINING URANIUM. W. E. Stephens and J. D. Christopher (National Lead Co. of Ohio, Cincinnati).

Uranium machining data were obtained and evaluated on 17 commercially available grades of carbide cutting tools. Tool life, tool-tip temperatures, and tool forces were measured for each grade over a range of machine speeds and feed rates. (auth)

13947 (NMI-2133) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report, October 1964. (Nuclear Metals. Div. of Textron Inc., West Concord, Mass.). Dec. 11, 1964. Contract AT(30-1)-2784. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Work on fabrication processes for W–Re tubing ¼-in. OD with 20-mil walls, and 80-mil OD tubing with 8-mil walls is reported. Drawing tests of the larger tubing revealed the occurrence of microcracks. Surface conditioning processes before drawing are being investigated to prevent the microcracks. Efforts are being devoted to establishing conditions for re-extruding smaller-size tubing using CaC_2 cores. Research on single-crystal deformation in zone-refined Be is also reported. (J.R.D.)

13948 (NP-14675) APPLICATION OF THIN-FILM ELECTRON MICROSCOPY TO REFRACTORY METAL PROCESSING. Quarterly Progress Report, September 12-December 11, 1964. R. P. Jewett (Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.). Jan. 11, 1965. Contract NOw 64-0299-d. 18p. (R-5776-3)

Results of a program to correlate refractory metal deformation and fine structure effects as observed by transmission electron microscopy are presented. The first experimental phase of the deformation of tantalum and tantalum–10 percent tungsten is complete. Deformation of molybdenum and TZM by cold-rolling at room temperature was completed, and examination by transmission electron microscopy was initiated. (auth)

13949 (NP-14768) EVALUATION OF MOLYBDENUM (TZM) SHEET. Quarterly Progress Report No. 2, September 9–December 9, 1964. R. E. Jackson (McDonnell Aircraft Corp., St. Louis). Dec. 24, 1964. Contract NOw 64-0456-c. 41p. (B068-2).

Effort during the second quarter of the TZM molybdenum sheet evaluation emphasized the fabrication studies. Uniform elongation tests were completed in the laboratory. Fabrication studies were made in the areas of joggling, corrugating, drop hammer forming (beading), dimpling, punching, and blanking. Details of the methods used and results obtained are given. (auth)

13950 (ORNL-TM-990) NONDESTRUCTIVE EVALUATION OF T-111 AND B-66 ALLOY TUBING. K. V. Cook and R. W. McClung (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 27p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

Nondestructive evaluation was carried out on approximately 306 ft of T-111 and B-66 alloy tubing with 0.250-in., 0.375-in., and 0.500-in. OD. Details of the particular nondestructive techniques that were applied are presented, along with the data generated by each testing method. It was shown that the most prevalent discontinuities are located on the outer surface of T-111 tubing and on the inner surface of B-66 tubing. (auth)

13951 (RMI-1) QUARTERLY PROGRESS SUMMARY, APRIL–JUNE 1964. (Reactive Metals, Inc., Ashtabula, Ohio). Nov. 11, 1964. Contract AT(30-1)-1405. 20p. Dep.; $1.00(cy), 1(mn) OTS.

A basic heat treatment study involving the number of heating cycles and the time at each cycle was performed on Mark V-B U billets. Analysis of the extruded product

from these billets indicates that a reduction in the number of cycles and time at each cycle could lead to a reduction in the amount of slug rejects for surface defects. The heat treatment of the billets had no effect on extrusion dimensions or pressure but rough surfaces were apparent on some tubes extruded from as-cast billets. A study was performed to determine the effects of extrusion press tooling alignment on the eccentricity of pierced I.D.'s. A description of the DYNAPAK equipment and process is presented including a summary of activities performed from its inception to its termination. Also presented is an engineering estimate of the cost of establishing a DYNAPAK extrusion facility for the production of Mark V-E Inner size U tubes. A final report concerning the refinement of coordinated extrusion, drawing, and heading techniques for the fabrication of cubical items was completed. (auth)

13952 (RTD-TR-8-112(Vol.IV)) EXTRUDING AND DRAWING MOLYBDENUM TO COMPLEX THIN H-SECTION. Interim Technical Engineering Report No. 4, May 1–July 31, 1964. P. A. Santoli (Allegheny Ludlum Steel Corp. Research Center, Brackenridge, Penna.). Aug. 1964. Contract AF33(657)-11203. 117p. (AD-605614). $4.00(OTS).

Sixteen H-shaped extrusions (14 TZM and 2 stainless) were made with new support tooling. No failure or distortion occurred in the tooling, regardless of liner pressure up to 237,000 psi. Reasonable quality and dimensional runout were found in TZM extrusions at a reduction ratio of 43:1 from 3200°F billet temperature with the use of flame-sprayed zirconia dies. Similar extrusions from 3350°F were poor. The use of pressed and sintered solid zirconia nibs was demonstrated successfully for the extrusion of 'H' shapes. Dimensional runout for both stainless and TZM was remarkably good and liner pressures were lower than that required for extrusions with segmented, coated dies. (auth)

13953 (TRG-Report-850) A THEORY FOR PREDICTING THE INTERFACE PRESSURE OF ROLLED JOINTS. D. L. Linning and H. Hatton (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England). Aug. 14, 1964. 14p. Dep.; $0.50(BIS); 2s. 6d. (HMSO).

When pipes cannot be joined by welding, one alternative is to make a rolled joint. Basically this process consists of running rollers round the inside of a tube/hub pair on an expanding pitch circle to produce a predetermined amount of plastic deformation in the tube. Such joints must rely to some extent on the development of a solid interface pressure. A fairly elementary theoretical approach to the problem is described, which yields a simple answer consistent with such observations as are so far available. The prediction is that in suitable circumstances, mainly the provision of a sufficiently strong hub, rolling develops a hoop compressive stress in the tube slightly in excess of its compressive yield stress, from which interface pressure can be readily calculated. (auth)

13954 (WANL-PR(P)-004) DETERMINATION OF THE WELDABILITY AND ELEVATED TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS. Quarterly Report No. 4, March 21–June 21, 1964. G. G. Lessmann and D. R. Stoner (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Contract NAS-3-2540. 31p. (NASA-CR-54166; N64-31455). $2.00(OTS).

TIG sheet butt welds for the weld parameter study have been completed for all of the available alloys except W–25Re and alloyed tungsten. A summary of current bend test results is given. EB welds for the weld parameter study have been completed for sheet material of four alloys and welding was initiated for two others. The results for Cb-752 and SCb-291 are presented. All available plate material has been machined with the double "U" weld joint configuration in preparation for welding and testing. The bead-on-plate restraint patch test was made for the W–25Re alloy. A tendency toward loss of ductility in the heat-affected zone and weld, and consequent cracking during welding was demonstrated. Modification of equipment and procedures are described. (D.L.C.)

13955 (WANL-PR-(P)-005) DETERMINATION OF THE WELDABILITY AND ELEVATED TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS. Fifth Quarterly Report, June 21, 1964–September 20, 1964. G. G. Lessmann and D. R. Stoner (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Contract NAS 3-2540. 74p. (NASA-CR-54232; N65-14394). $3.00(OTS).

TIG sheet butt welds for the weld parameter study have been completed for all of the available alloys except W–25Re and unalloyed tungsten. With the exception of T-111 and As-55 which have not yet been bend tested, test data for the remaining alloys are presented in this report. A summary of current bend test results is graphically shown. EB sheet butt welds for the weld parameter study have been completed for all available alloys except AS-55 and unalloyed tungsten. Bend test data on two additional alloys, D-43 and W–25Re, are presented. Unexpectedly high bend ductile-brittle transition temperatures (in some cases exceeding 1000°F using a 4t bend radius) have been obtained for the W–25Re EB welds. A review of this problem has been undertaken. A thorough evaluation of the high vacuum annealing furnace performance under simulated long time aging conditions was made. A high initial hydrogen load was observed during the first five hours of furnace operation. After this, carbon monoxide was the principal gas load component. Titanium sublimation pumping was least effective in improving the pumping of hydrogen and moisture and most effective in improving the pumping of inert gases. Latex natural rubber gloves were evaluated for use on the TIG weld chamber and were found to be inferior to neoprene. Techniques were developed for gold–nickel brazing of platinum–platinum rhodium thermocouples into the high vacuum annealing furnace feedthroughs. (D.L.C.)

13956 (JPRS-27976) INDUSTRIAL SAFETY IN WORK WITH BERYLLIUM AND ITS ALLOYS. I. A. Akopov, D. M. Bobrishchev-Pushkin, A. K. Prokof'eva (Prokof'yeva), and K. P. Yatsenko. Translated from p.1-107 of "Bezopasnost' Truda pri Rabote s Berilliem i Yego Splavami," Moscow, 1964. 110p. (TT-64-51994). $4.00(OTS).

The book presents the physical and chemical properties of beryllium and its alloys; their toxicity, characteristics of casting, rolling, mechanical treatment, and welding are described. A classification of operations with respect to toxicity is presented, and the requirements for safety techniques are discussed. Great attention is paid to labor hygiene in various processes of beryllium production and the treatment of alloys containing beryllium. In connection with the wide use of the cast alloys VAL2, AL8U, and others in industry, concrete data are presented on the characteristics of working conditions during their production and processing. (auth)

13957 (JPRS-28330) CASTING OF REFRACTORY METALS. B. B. Gulyaev (Gulyayev), O. N. Magnitskii (Magnitskiy), and A. A. Demidova. Translation of p.3-192 from "Lit'ye iz Tugoplavkikh Metallov," (a publication of the Machine-Building Publishing House, Moscow-Leningrad, 1964). 311p. (TT-65-30143). $7.00(OTS).

The book correlates available materials on the casting of refractory metals. Its five chapters cover the following respective topics: characteristics of metals, reactions with surrounding media, equipment for melting and pouring, technology of casting, and properties of alloys. (D.L.C.)

13958 (ORNL-tr-408) SPECIAL EQUIPMENT FOR THE WELDING OF THE REACTOR VESSEL OF THE FIRST CZECHOSLOVAK ATOMIC POWER PLANT. Richard Kotora and Miloslav Kroft. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 33-9(1964). 15p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

A description is given of some of the special auxiliary equipment used in the electroslag welding of the sections of the pressure vessel for the KS-150 reactor. These equipment include the positioners and heat treatment apparatus, and their operation in the welding of the top and bottom and of the body rings is discussed. (D.L.C.)

13959 TECHNIQUES FOR THE FABRICATION OF ULTRA-THIN METALLIC FOILS. Frank J. Karasek. Argonne Natl. Lab. Rev., 2: No. 1, 16-19(Jan. 1965).

Methods of fabricating foils of chromium, tungsten, gadolinium, and a modified 310 stainless steel are described. Equipment for melting, casting, annealing and heating, rolling, and weighing is considered. (M.C.G.)

13960 THE PREPARATION AND EXAMINATION OF MIXTURES OF ALUMINIUM NITRIDE (AlN) AND URANIUM MONONITRIDE (UN). T. J. Davies and P. E. Evans (Manchester Univ., Eng.). J. Nucl. Mater., 13: 152-68 (1964).

Aluminum nitride (AlN) is a refractory material that is strong, hard, of low density, chemically inert, and that has good resistance to thermal shock. These properties and its nonreactivity with uranium mononitride (UN) at temperatures up to 1600°C indicated that it may be a suitable matrix material for a ceramic nuclear fuel composite. Methods of preparation and consolidation of AlN and UN and determinations of thermal conductivity, thermal expansion, and resistance to thermal shock and oxidation resistance are described. (auth)

13961 PREPARATION OF URANIUM DIOXIDE–MOLYBDENUM BODIES. Erich Gebhardt and Gerhard Ondracek (Max-Planck-Institut fur Metallforschung, Stuttgart). J. Nucl. Mater., 13: 210-19(1964). (In German)

The preparation of UO_2–Mo cermets by cold pressing and sintering is characterized by the quality of the powder and the mixing and the densification conditions. The powders used had an average diameter of 2.6 μm for Mo and of 16.4 μm for UO_2. These particulars were determined from the measured frequency distribution of the particle sizes. The UO_2 granules had approximately spherical shape, while the Mo granules were of irregular form. The uranium dioxide used had a composition of $UO_{2.21}$. The shape of the particles were in accord with the measured apparent density and the tap density of the pure components. The powder achieved a sufficient homogeneity after treating for 50 hours in a mixing apparatus (75/rpm). The apparent density of the mixed powders was always higher than that of the pure components. On the other hand, the tap density showed a continuous increase from uranium dioxide to pure molybdenum. The experimental correlation between green density, sintering density, and Mo concentration revealed a range of irregular change in density in the range from 30 to 40 wt % Mo. The same irregular concentration dependence was also observed in the dilatometric experiments for determining the temperature of incipient sintering. These results can be explained by assuming a change in the matrix from uranium dioxide to molybdenum as the composition is changed. (auth)

13962 SYNTHESIS OF THE SYSTEM URANIUM DIOXIDE–MOLYBDENUM. Erich Gebhardt and Gerhard Ondracek (Max-Planck-Instutut fur Metallforschung, Stuttgart). J. Nucl. Mater., 13: 220-8(1964). (In German)

Sintered specimens of uranium dioxide and molybdenum were examined by x-ray diffraction and micrographic analysis. Specimens were examined over the whole range of concentration. The annealing was done at 800 (4916 hr), 1500 (20 hr), and 1750°C (5 hr). However, there was no indication of any reactions between the components or formation of a solid solution. These results were in good agreement with the literature data. An electron beam furnace was used in further annealing treatments, carried out above the melting points of both the components. The results in the melting range of the cermets were the same as in the case of solid state; there were no indications of reactions. In the case of the liquid state, there was complete dissociation up to a temperature of 2900°C. From the microstructure and x-ray examination, a phase diagram was derived for the uranium dioxide–molybdenum system. (auth)

13963 METALLOGRAPHIC PREPARATION OF DICARBIDES OF THORIUM AND THORIUM–URANIUM. T. M. Kegley, Jr., and B. C. Leslie (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 13: 283-7(1964). (ORNL-P-22)

Dicarbides of thorium and thorium–uranium were prepared by either vibratory polishing inside a dry box or by mechanical polishing outside a dry box. Specimens were etched by immersing in nitric acid. Vibratory polishing required more time than mechanical polishing, but produced a better quality of polish in that there were fewer scratches and a flatter surface. (M.C.G.)

13964 THE PREPARATION OF NONPYROPHORIC URANIUM POWDERS. L. Jakesova and J. Wolf (Nuclear Research Inst., Czechoslovakian Academy of Science, Prague). J. Nucl. Mater., 15: 73-80(1965). (In German)

The influence of reduction temperature (900 to 1100°C), time of reduction (0.5 to 4 hr), and of additions of calcium chloride (2 to 10 wt %) on the disperseness and granulometric composition of uranium powder obtained by reducing uranium oxide with calcium hydride was studied. In the range of temperature used the influence of temperature, reduction time, and addition of calcium chloride were established. The results are presented graphically. A brief examination was also made of the influence of the mass of the reaction mixture. The stability of the uranium powder in free air was also tested. (auth)

13965 STUDIES OF THE SINTERING BEHAVIOUR OF PLUTONIUM DIOXIDE. P. E. Potter (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 15: 100-4(1965). (AERE-R-4729)

The sintering behavior of two samples of plutonium dioxide was examined. The effects of calcination temperature, sintering atmosphere, and temperature were studied. It was found that for one oxide at temperatures of 1300 and 1500°C, wet hydrogen was the sintering atmosphere in which the highest densification occurred for the powders of smallest particle size. For the other oxide an air atmosphere was the best for densification. The difference in behavior is explained by differences in the iron impurity content. The largest particle size material sintered little under all conditions and poor densification was also obtained when the sintering temperature was lowered to 1100°C. (auth)

13966 CAUSES OF HIGH TEMPERATURE SUBSTOICHIOMETRY IN SINTERED URANIUM DIOXIDE. I. Amato, R. L. Colombo, and A. M. Petruccioli Balzari (Fiat, Turin). J. Nucl. Mater., 15: 125-8(1965).

Inclusions of uranium metal in arc-melted UO_2 were observed. An attempt was made to relate uranium metal segregation to the addition of organic products to the powder prior to pressing. It was found that in these cases a certain amount of U_2C_3 precipitates at the grain boundaries of UO_2, provided the time at high temperature (about 1800°C) is long enough. At even higher temperatures mono- and dicarbides were formed and carbon monoxide emitted. These uranium inclusions were found to drastically impair corrosion resistance. (M.C.G.)

13967 THE THINNING OF SINTERED URANIUM DIOXIDE TO ELECTRON TRANSPARENCY BY CHEMICAL POLISHING. A. J. Manley (United Kingdom Atomic Energy Authority, Windscale, Cumb., Eng.). J. Nucl. Mater., 15: 143-5(1965). (TRG-Report-847)

A chemical polishing technique was developed for thinning massive UO_2 for transmission electron microscopy. It may be possible by this method to thin sintered UO_2, which was irradiated at high temperatures. The UO_2 was sintered in the form of pellets, and discs were cut from the pellets. These discs were ground to a thickness of 300 to 400 μ, using a steel block with a close-fitting circular recess of variable depth. The thickness of the central region of the disc was then reduced to 40 to 80 μm by means of a high-velocity air-borne jet of 10 μ alumina. Two different chemical polishing techniques were used for subsequent reduction of the disc to electron transparency: polishing with a solution of acetic acid, chromium trioxide, hydrofluoric acid, and nitric acid and/or with a solution of orthophosphoric acid, acetic acid, and nitric acid. The sintered UO_2 samples were characterized by their almost complete lack of structural features. (M.C.G.)

13968 STUDY OF THE METHODS OF BERYLLIUM EXTRACTION CARRIED THROUGH FOR THE PURPOSE

OF REDUCING THE GENERAL COST OF PRODUCTION. F. Vogel. Metall, 18: 1300-5(Dec. 1964). (In German)

Methods used for processing beryl and the production of beryllium metal from beryl concentrates were analyzed to determine the most economical procedures. The essential steps in the processing of beryl were heating the beryl and quenching in cold water, pulverization, treatment with HF, treatment with NaOH, and dissolving the concentrate with sodium hydrogen fluoride. The hydroxide of beryllium was then prepared, and Be was produced electrolytically from the melts. (J.S.R.)

13969 CONTRIBUTION TO THE TECHNOLOGY OF THE RARE EARTH METALS. E. Erben (W. C. Heraeus GmbH, Hanau, Ger.). Metall, 18: 1310-12(Dec. 1964). (In German)

The technology of the melts and non-cutting shaping of the rare earths La, Nd, Sm, Eu, Tb, Dy, Ho, and Er are described and explained. (tr-auth)

13970 TANDEM-EXTRUDED JOINTS UNDAMAGED BY IRRADIATION. J. Walter Joseph, Jr. (E. I. du Pont de Nemours & Co., Aiken, S. C.). Nucleonics, 22: No. 12, 64(Dec. 1964). (TID-20092)

Tandem-extruded tubular joints were developed suitable for low-temperature use in power reactors for connections between Zircaloy pressure tubes and stainless-steel head piping. A summary of unirradiated-joint tests of mechanical and corrosion performance is given. Irradiation tests consisted of stressing in axial tension at about 50°C during exposures to 7.8×10^{20} fast neutrons/cm^2; postirradiation examinations showed that the joints were undamaged by irradiation under load. (M.J.T.)

13971 THE METALLOGRAPHY OF HIGH-MELTING METALS. I. TUNGSTEN AND MOLYBDENUM. Hansjoerg Stadler and Albin Ihrenberger (Metallwerk Plansee, Reutte, Tyrol, Austria). Prakt. Metallog., 1: 59-66(June 1964). (In German)

Electrolytic polishing and etching methods for molybdenum and tungsten specimens in various states of treatment were compared with electrolytic lap polishing. Instructions are given and advantages of this method emphasized. (auth)

13972 PRODUCTION OF A DENSE UO_2 NUCLEAR FUEL FROM THE BY-PRODUCTS OF THE PRODUCTION OF METALLIC URANIUM. M. M. Ristic (Boris Kidrich Inst. of Nuclear Sciences, Vinca, Yugoslavia). Tonind. Ztg. Keram. Rundschau, 88: 4p. (1963).

The possibility of utilization of metallic uranium powder for the production of sintered UO_2 of high density was investigated. The fraction < 60 μm of the powder had a characteristic temperature difference of 158°C. These results showed that the material belongs to the sinterable powders. Some studies were made on the sintering properties. Sintering of this powder in a hydrogen or nitrogen atmosphere showed that samples of high density (up to 96% theoretical weight) can be prepared. Sintered UO_2 powder of high density could also be obtained by sintering an intermediate product in the production of metallic uranium. (tr-auth)

13973 EFFECT OF CERTAIN ADDITIVES ON THE SINTERING OF MULLITE. P. P. Budnikov, T. N. Keshishyan, and A. V. Volkova. Ukr. Khim. Zh., 30: 986-91(1964). (In Russian)

The addition of up to 5% BeO, MgO, or CaO had different effects on the sintering of mullite and the character of its crystallization. Samples containing 5% BeO, MgO, or CaO calcined at 1750°C (sintering was not attained at lower temperatures) had densities of about 90% of theoretical. Petrographic studies of the samples containing 5% of the different additives and calcined at 1750°C established that there were no other crystalline phases except the mullite. X-ray analysis confirmed absence of other crystalline phases. The deviations from the normal line intensity relationships in the x-ray diagrams led to the assumption that the additives were embedded in the mullite lattice. The ability to embed decreased with increasing atomic weight and ionic radius of the additive cation. The additives lowered the fusion temperature of the mullite very little. In mullite samples with no additive or in BeO containing mullite, the structure contained no glass and consisted of sharp needle-like crystals. The mullite containing 5% CaO contained visible amounts of glass and uneven crystals. (OTS)

13974 QUALITY CONTROL IN FABRICATION OF NUCLEAR PRESSURE VESSELS. An AEC Monograph. Robert D. Wylie (Southwest Research Inst., San Antonio) and Warren J. McGonnagle (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Monograph Series on Metallurgy in Nuclear Technology. New York, Rowman and Littlefield, Inc., 1964. 194p. $9.65(Case Bound), $5.35(Paper Bound).

This book outlines a quality control program to be followed in the design and fabrication of pressure vessels for nuclear applications. Codes and specifications, organization for quality control, metallurgy, welding, heat treatment, machining, inspection, testing, and economics are covered. (D.L.C.)

13975 THE STRUCTURAL APPLICATION OF BERYLLIUM TO THE GEMINI SYSTEM. H. C. Turner (McDonnell Aircraft Corp., St. Louis). 28p. (CONF-729-11)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

Beryllium in cross rolled plate was applied to the Gemini spacecraft primarily to absorb heat on reentry, but with strength requirements to resist air loads at elevated temperature and to resist accidental impact loads on docking. Shingles were hot formed to contour, mechanically and chemically machined to finished dimensions and anodized and coated to meet emissivity requirements. Mechanical property tests of raw material at room and elevated temperature and docking impact tests of a production shingle at −100°F verified its ability to conform to specified requirements. (auth)

13976 DEVELOPMENT OF METHODS OF PRODUCING BERYLLIUM TUBES FOR NUCLEAR FUEL ELEMENT CANS. P. B. Eyre (United Kingdom Atomic Energy Authority, Springfields, Lancs, Eng.), L. J. Williamson, and L. R. Williams. 39p. (CONF-729-16)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

Experience on the development of beryllium tubes intended for use in a gas cooled reactor is discussed. In all cases beryllium powder was the starting material and the results from two consolidation techniques are included. The loose sintering process was found to be satisfactory with certain grades of intermediate purity. Because of the marked dependence of density on composition of the loose sintering process and the unknown effect of impurity additions on various properties and the requirement for high density material for the extrusion operation, the vacuum hot pressing process was used to produce experimental billets from the purer material for direct warm extrusion or for hot extrusion. A simple hot retort process for pressing billets 4−5 in. dia and 7½ in. long is described. A warm extrusion technique was employed as the final extrusion process in order to obtain the necessary dimensional accuracy. The extrusion procedure is discussed and the selection of tool materials, particularly for mandrels, which was found to be necessary, is commented on. Tubes produced by the extrusion route were found to behave unexpectedly and the work to determine the cause of this is briefly discussed. The investigation of tubes with lower degrees of preferred orientation led to the examination of machining of tubes from vacuum hot pressed block. The vacuum hot pressing route was examined in more detail and the relationship between overall block density—localized low density areas—and gas permeability established. The relationship between pressing pressure and anistropy of mechanical properties was examined and only in the case of reduction in area was there found to be any well defined correlation. Mechanical tests of tubes drilled from these blocks and the results of some fuel element evaluation tests showed that this type of tube was superior to those produced by extrusion. (P.C.H.)

Properties and Structure

Refer also to abstracts 13281, 13590, 13601, 13613, 13615, and 13938.

13977 (AD-609726) DIFFUSION STUDIES IN CERAMIC CRYSTALS. Final Report. Leonid V. Azaroff (McCrone Research Inst., Chicago). Nov. 1964. Contract 3964(01)74. 9p. $1.00(OTS).

A research program is being conducted on the anisotropy of diffusion in ceramic crystals having open structures. Some diffusion runs were carried out using ^{115}Cd tracer on CdS and ZnS crystals, and the preliminary data on the diffusion coefficients parallel and perpendicular to the c axis are presented. (D.L.C.)

13978 (AMRA-TR-64-16) EVALUATION OF REFRACTORY METAL SHEET ALLOYS. George E. Gazza and Thomas S. DeSisto (Army Materials Research Agency, Watertown Arsenal, Mass.). July 1964. 19p. (AD-608164). $0.50(OTS).

Five niobium base alloys, three tantalum base alloys, and two molybdenum base alloys were evaluated. Mechanical properties were determined by tensile testing at room temperature and elevated temperatures, stress rupture testing, and bend testing of base metal specimens and welded specimens. The properties of the alloys are compared with target requirements established by the Alloy Requirements and Selection Group, Materials Advisory Board. Significant progress in refractory metal sheet development is demonstrated by a comparison of the test data with target properties. In general, the properties of the alloys approached or exceeded the target requirements. (auth)

13979 (ASD-TDR-63-567(Pt.II)) STUDY OF LOCAL-ORDER AND SOLID-SOLUTION STRENGTHENING IN COLUMBIUM ALLOYS. P. S. Rudman (Battelle Memorial Inst., Columbus, Ohio). Aug. 1964. Contract AF33(657)-8844. 37p. OTS.

An attempt was made to establish whether Fisher's local-order solution-strengthening mechanism is important in Nb-base alloys. X-ray diffuse-scattering studies of Nb–V alloys showed that the alloys are nearly random and that there is considerable atom-size accommodation in solution. Strengthening due to atom-size difference in a substitutional binary alloy is shown to depend on composition fluctuations, and yield-strength data for Nb–V alloys agree with predictions made using a regular solution model. A theory of atom-size-difference-induced short-range order (SRO) is presented in which strain relaxation and equilibrium degree of SRO are calculated for Cu_3Au. (D.L.C.)

13980 (ATL-A-144) INVESTIGATION OF THERMAL-STRESS-FATIGUE BEHAVIOR OF STAINLESS STEELS. Final Report. K. E. Horton and J. M. Hallander (American Radiator and Standard Sanitary Corp. Advanced Technology Labs. Div., Mountain View, Calif.). Oct. 31, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 127p. (EURAEC-1299) Dep.(mn); $4.00(cy), 3(mn) OTS.

In an effort to fatigue-test nuclear reactor materials under conditions similar to those that would be expected in actual practice, a thermal-stress-fatigue program was conducted in which stress cycling was induced by thermally cycling a constrained specimen. A major departure from conventional data-presentation methods was made by plotting logarithmic plastic strain range versus logarithmic cycles to failure. A summary is presented of results of thermal-stress-fatigue testing on types 304 and 304-L austenitic stainless steels; type 403 martensitic stainless steel; types A302-B and A387-D (Croloy 2¼) steels; Incoloy 800; and Zircaloy-2. The thermal-stress-fatigue behavior of these alloys was determined under a wide variety of test conditions. A contribution to the field of fatigue testing was made by the development of a plastic-strain-measuring device and of techniques for graphical manipulation of recorded data. It was thus possible to report fatigue life in a range less by an order of magnitude than previously reported data. The use in this study of cyclic plastic strain instead of cyclic stress on graphs of fatigue life resulted in curves largely independent of such test conditions as mean temperature, time, and strain rate. The results hence can be used, with little or no extrapolation, to estimate thermal-stress-fatigue life. Since the majority of fatigue results from earlier work are plotted on a stress basis, and test results obtained in this program are also plotted on this basis. (D.L.C.)

13981 (CONF-651-45) ELECTRON TRANSPORT PHENOMENA AND OSCILLATORY BEHAVIOR IN THE LATTICE CONDUCTIVITY OF AN Sb SINGLE CRYSTAL IN A MAGNETIC FIELD AT LOW TEMPERATURE. C. G. Grenier, Jerome R. Long, J. M. Reynolds, and N. H. Zebouni (Louisiana State Univ., Baton Rouge). [1964]. Contract [AT(40-1)-3087]. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

With the magnetic field parallel to the trigonal direction the experimental coefficients of the transport effects were measured in the basal plane of an antimony crystal, i.e., in a transverse field. The zero field resistance ratio was ≈4000. Measurements were performed at 4, 3, 2.1, and 1.6°K in a field ranging from 0.1 to 17.8 kgauss. The experimental coefficients of the transport effects, the kinetic coefficients of the transport effects, and the lattice conductivity were discussed. (C.E.S.)

13982 (CONF-729-3) FINE GRAIN SIZE IN BERYLLIUM BY SPLATCOOLING. A. R. Kaufmann and W. C. Muller (Nuclear Metals, Div. of Textron Inc., West Concord, Mass.). [Oct. 1964]. For Univ. of California, Lawrence Radiation Lab., [Berkeley]. Contract W-7404-eng-48. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Conference on Beryllium, Philadelphia, Oct. 1964.

A preliminary study was made of splatcooling as a means of preparing fine-grained Be with a relatively low oxygen content. Splatted and consolidated Be specimens were found to contain less than 5000 ppm BeO, and metallographic examinations of the structure were made. Tensile and bend tests show high combinations of strength and ductility. (D.L.C.)

13983 (GA-4675) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending September 30, 1963. R. J. Price and J. L. White (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 31, 1964. Contract AT(04-3)-167. 47p. Dep.(mn); $2.00(cy), 2(mn) OTS.

Activities in a program to characterize the microstructure of graphitic materials, modify graphite microstructure, and determine the relations between graphite microstructure and physical properties are reported. Initial efforts were devoted to hot-working graphite and graphite–carbide bodies and to investigation of the relations between preferred orientation and directional properties of graphitic materials. Work is also reported on development of a high-temperature test facility. (J.R.D.)

13984 (GA-5520) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report for the Period Ending April 30, 1964. R. H. Chambers and T. A. Trozera (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. 21p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Results of work on vapor-deposited high-purity W crystals indicate that these crystals are suitable for irradiation testing. Other work is described on swaging of W crystals and modification of the electron-gun assembly. A new model of stress-amplitude and temperature-dependent dislocation motion applicable to the high-stress-amplitude data obtained in high-purity Ta and Nb test specimens is described. (J.R.D.)

13985 (GEAP-4535) CORRELATION OF UO_2 MICROSTRUCTURES FROM IN-PILE AND OUT-OF-PILE EXPERIMENTS. H. Hausner and R. C. Nelson (General Ele-

tric Co. Vallecitos Atomic Lab., San Jose, Calif.). June 4, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 55p. (EURAEC-1321). Dep.(mn); $3.00 (cy), 2(mn) OTS.

A comparison was made between microstructures obtained from out-of-pile experiments and from irradiated material. The main differences are discussed. The influence of temperature and duration of the heat treatment on the microstructural changes below the melting point was investigated, and temperatures for the onset of these changes were calculated. Microstructures obtained after melting are discussed, and changes of these structures by a subsequent heat treatment below the melting point are shown in both in-pile and out-of-pile experiments. (auth)

13986 (HW-SA-3779) COMPUTER PROGRAM FOR ELECTRON DIFFRACTION INTENSITIES. K. R. Merckx (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 25, 1964. Contract AT(45-1)-1350. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A computer program is described for predicting the intensity distributions of electrons transmitted through thin foils containing structural defects. The program calculates the diffracted and transmitted intensities around a dislocation in a foil having only one operating diffracting plane. The numerical methods and geometrical parameters used in the program are described. The program makes use of the two-beam dynamical theory of diffraction. (T.F.H.)

13987 (IGR-TM/C-0176) SPECIFIC HEATS OF GRAPHITE, MAGNESIUM (MAGNOX A12) AND URANIUM. N. F. Godwin (United Kingdom Atomic Energy Authority. Industrial Group. Culcheth Labs., Culcheth, Lancs, England). Aug. 1958. 21p. (IGC/RKWP/P-19). Dep.(mn).

Equations were computed from available data for the variation of specific heat with temperature for graphite, Magnox A12, and uranium. The data referred, in general, to commercial grade material but it is not considered that the specific heats of reactor grade material will differ significantly. Scatter of the data from the computed curves was found to be within ±2 to 5%. (D.L.C.)

13988 (LA-3191) METALLOGRAPHIC PREPARATION AND OBSERVATIONS OF SOME PLUTONIUM–CARBON ALLOYS. K. Allan Johnson (Los Alamos Scientific Lab., N. Mex.). Nov. 5, 1964. Contract W-7405-eng-36. 16p. Dep.; $1.00(cy), 1(mn) CFSTI.

The metallographic preparation of plutonium–carbon alloy samples having compositions in the range 38 to 57 at.% carbon is described, and some of the optical microscopy, microhardness, volume fraction analysis, and x-ray diffractometry results thus obtained are presented. (auth)

13989 (LA-3192) TENSILE TESTS ON INVAR SHEET AT CRYOGENIC TEMPERATURES. David T. Eash (Los Alamos Scientific Lab., N. Mex.). Nov. 4, 1964. Contract W-7405-eng-36. 12p. Dep.; $1.00(cy), 1(mn) CFSTI.

A series of tensile tests was conducted on 0.005-in.-thick Invar sheet in the mill-annealed condition at 300, 77, and 20°K. The tests were made to determine the yield and tensile strengths, notched-to-unnotched strength ratio, ductility, and toughness at cryogenic temperatures. It was observed that the yield and tensile strengths increased at low temperatures by a factor of at least two; the ductility remained good; and the toughness, as indicated by the notched-to-unnotched tensile strength ratio, decreased. (auth)

13990 (MCW-1488) EQUILIBRIUM STRUCTURES IN THE HIGH URANIUM–ALUMINUM ALLOYS SYSTEM. J. A. Straatmann and N. F. Neumann (Mallinckrodt Chemical Works. Nuclear Div., Weldon Spring, Mo.). Nov. 11, 1964. Contract W-14-108-eng-8. 23p. Dep.; $2.00(cy), 1(mn) CFSTI.

The boundaries and phase fields existing in uranium alloys containing from 80 to 4000 ppm by weight aluminum at temperatures from 600 to 1200°C have been determined from differential thermal, metallographic, and microprobe analyses. The phase diagram and the methods used to determine it are included as well as micrographs of the studied specimens. Photographs of retained beta-uranium and the resulting shear-transformed alpha-uranium are also included. (auth)

13991 (ML-TDR-64-134) EQUILIBRIUM SOLUTIONS OF NITROGEN IN COLUMBIUM-BASE ALLOYS. E. deLamotte, Y. C. Huang, and C. J. Altstetter (Illinois. Univ., Urbana). June 1, 1964. Contract AF33(657)-10626. 28p. (AD-602829). $2.00(OTS).

Thermodynamic and mechanical properties of niobium–nitrogen and niobium–zirconium–nitrogen alloys were determined. The partial pressure of nitrogen in equilibrium with single-phase and two-phase alloys of various binary and ternary compositions was determined as a function of temperature for temperatures between 1500 and 2100°C. Heat of solution of nitrogen, heat of formation of Nb_2N, and heat of solution of Nb_2N values were determined for pure niobium and niobium with 0.86 wt % Zr. Internal friction and hardness were measured for several alloys which had been quenched from above 1500°C. For the radiation quench used, solid solutions with 0.075 wt % nitrogen and over could not be retained without precipitation. For the coarse-grained specimens, hardness increased from 107 KHN for the pure niobium to 178 KHN for a two-phase alloy containing 0.68 wt % nitrogen. (auth)

13992 (ML-TDR-64-234) ELECTRICAL RESISTIVITY OF NIOBIUM–ZIRCONIUM ALLOYS BELOW 273.2°K. Donald J. Evans (Wright Air Development Center. Materials Lab., Wright-Patterson AFB, Ohio). July 1964. 33p. (AD-609798). $2.00(OTS).

An apparatus for measuring the electric resistivity of materials from 4.2°K up to 273.2°K was constructed and used to test niobium–zirconium alloys of the following compositions: Nb + 15% Zr, Nb + 25% Zr, Nb + 33% Zr, and Nb + 50% Zr. It was found that the temperature dependence of the electrical resistivity of these alloys is approximately linear, with Matthiessen's Rule holding for the lower concentrations. The residual electric resistivity is shown to depend linearly on zirconium concentration. (auth)

13993 (NLCO-940(p.7.1-4)) DETERMINATION OF THE TRANSFORMATION TEMPERATURES OF DILUTE ALLOYS OF URANIUM BY DIFFERENTIAL THERMAL ANALYSIS. S. F. Paris (National Lead Co. of Ohio, Cincinnati).

A vacuum differential thermal analyzer was used to determine the allotropic transformation temperatures of slightly alloyed uranium. Data are presented on the alpha-to-beta and beta-to-alpha transformation temperatures of ten alloys of uranium containing aluminum, silicon, carbon, and iron. (auth)

13994 (NLCO-940(p.8.1-4)) CONVERSION OF AN OPTICAL MICROSCOPE TO MEASURE THE REFLECTANCE OF GRAINS IN METALLIC SAMPLES. W. W. Brock and J. W. Colby (National Lead Co. of Ohio, Cincinnati).

A conventional optical microscope was converted to a highly sensitive microphotometer to measure the reflectance of grains in polished metal samples. Grain reflectance shows promise of being convertible to grain orientation, and measurement of a finite number of grains is expected to show the texture of the sample. (auth)

13995 (NMI-6021.13) FINE GRAIN SIZE IN BERYLLIUM BY SPLATCOOLING. Final Report. A. R. Kaufmann and W. C. Muller (Nuclear Metals, Inc., West Concord, Mass.). Nov. 15, 1963. For Univ. of California Lawrence Radiation Lab., Berkeley. Contract AT(30-1)-1565. 60p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A technique was developed to produce beryllium polycrystalline particles having grain size of 1 to 5 microns by splatcooling molten droplets produced from rotating feed electrodes. These fine grain particles were consolidated by hot pressing to full density producing sound compacts of material in sizes sufficient for determining the mechanical and physical properties. Evaluation of

the consolidated splat particles determined that compaction at 650 and 700°C as well as short time anneals at 800°C had little to no effect upon the grain size; compaction at 750 and 800°C did produce moderate grain coarsening. Short time anneals at a temperature of 1000°C produced large grains occurring within the particle boundaries. It appears that grain growth will not readily occur across the particle boundaries, presumably due to a thin oxide film on the splat particle faces. Increased compaction temperatures or short time anneals improved the ductility of the compacted splats. The strength, elongation, and reduction of area of consolidated Pechiney CR-grade splat particles are unusually high as compared with ordinary forms of randomly oriented beryllium. Bend tests performed on specimens of compacted CR-grade splats indicate the material as presently developed has approximately the same ductility under biaxial stress conditions as commercial grade hot pressed beryllium block. It is believed that further developments in the technology of splatcooling low oxygen beryllium and consolidation of these splat particles into fully dense compacts will lead to better mechanical properties than are now available in commercial purity beryllium. (auth)

13996 (ORNL-P-1051) AGING OF COLUMBIUM ALLOY D-43. T. K. Roche (Oak Ridge National Lab., Tenn.). [nd]. Contract [W-7405-eng-26]. 6p. (CONF-650203-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

From National American Institute of Mechanical Engineers Meeting, Chicago.

A study was made of the aging characteristics of the D-43 alloy over the temperature range of 1800 to 2600°F following high-temperature annealing. The kinetics of the aging reaction was studied, and it was found that the cooling rate from the annealing temperature had a large effect on the ductility. The microstructures developed in D-43 after aging and cooling are described. (D.L.C.)

13997 (RSIC-202) THERMAL PROPERTIES OF HIGH-TEMPERATURE MATERIALS. W. D. Wood and H. W. Deem (Battelle Memorial Inst., Columbus, Ohio). June 1, 1964. Contract DA-01-021-AMC-203(Z). 407p.

This report is a compilation of specific-heat, thermal-expansion, and thermal-conductivity data for materials of possible structural usefulness above 2500°F. Data are presented graphically with notations as to measurement methods and test conditions. Prominent laboratories currently making thermal-property measurements are identified. (auth)

13998 (SAN-8002(p.210-30)) INVESTIGATION OF THE PHYSICAL PROPERTIES OF MATERIALS IN HIGH-TEMPERATURE SODIUM. R. C. Andrews (MSA Research Corp., Callery, Penna.).

Tests of the physical properties of type 316 SS and 2¼ Cr–1 Mo steel specimens in low-oxide sodium, helium, and air at 1200 and 1100°F respectively, have been carried out. (auth)

13999 (SWRI-1228-43) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. (1) CYCLIC PRESSURE TESTS OF LARGE-SIZE PRESSURE VESSELS. (2) LOW-CYCLE FATIGUE TESTING OF ONE-HALF SCALE MODEL PRESSURE VESSELS. (3) EFFECT OF WELD DEFECTS ON THE FATIGUE STRENGTH OF A302B STEEL. Progress Report No. 11. A. G. Pickett, S. C. Grigory, A. R. Whiting, and H. C. Burghard (Southwest Research Inst., San Antonio). Nov. 16, 1964. Contract AT(11-1)-1228. 68p. (SWRI-1228-44; SWRI-1228-45). Dep.(mn); $3.00(cy), 2(mn) OTS.

Activities in a program to develop information for use in analysis or prediction of pressure vessel strength and service life are reported. The investigation of plastic fatigue strength of large pressure vessels is being conducted at several laboratories. The vessels under study at Southwest Research Institute are 36 in. ID and have 2-in. wall thicknesses. Results obtained by the various laboratories will be compared. Models having 18-in.-ID are being investigated to determine the size effect on fatigue strength. An investigation to determine the effects of weld defects on the plastic fatigue strength of A302B steel is also in progress. (J.R.D.)

14000 (TID-21478) DETERMINATION OF PHASE EQUILIBRIA IN THE SYSTEM BeO–ThO_2. First Quarterly Report. Henry E. Otto (Denver, Univ. Denver Research Inst.). Dec. 15, 1964. Contract AT(11-1)-1092. 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Sintered BeO–ThO_2 pellets were used in an attempt to determine the solidus temperature by visual observation. A great deal of scatter was obtained in the data. Ceramographic inspection was then used, and the results indicate that the eutectic temperature lies between 2120 and 2150°C. (D.L.C.)

14001 (TID-21623) INITIAL GRAIN GROWTH STUDIES OF THORIA GEL. Technical Report No. XXV. Byong D. Chun and Milton E. Wadsworth (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Dec. 1, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 2176. 47p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Thoria gel was fired in nitrogen atmosphere in the temperature range from 786 to 1122°C. The grain size was determined by means of electron microscopy. From 860 to 1000°C normal grain growth was observed to occur. However, above 1000°C erratic grain growth took place and resulted in the formation of isolated large grains which grew at an accelerated rate. This effect has been attributed to the simultaneous sintering of the grains and the presence of nitrate in the gel. It has been found that the removal of nitrate at elevated temperature occurs at a much slower rate than previously suspected. It was also found that the large erratic grains which formed during initial grain growth would recrystallize forming a matrix of smaller grains which again would repeat erratic grain growth and recrystallization. This unusual behavior was observed repeatedly and was found to be influenced by presoaking temperature, presoaking time, and atmospheres used. Following the initial erratic grain growth period, it was observed that the grain growth patterns followed the normal grain growth equations from which it was possible to determine the activation energy for the grain growth process. Using data for grain growth over the temperature region 1000 to 1096°C, the activation energy was determined to be 35.6 kcal/mole. Further, atmospheric effects on grain growth were studied using hydrogen, nitrogen, and oxygen with a presoaking period in order to eliminate strain and impurities as completely as possible. Presoaking was found to eliminate the erratic growth of large grains, instead a few isolated large grains, which did not grow further, appeared in the thoria gel fired for a short time period. It did not, however, eliminate the growth of a homogeneous matrix of large grains which deviated from the normal grain growth patterns. Reducing atmospheres enhanced grain growth which may be explained in terms of the defect state of thoria as influenced by the atmosphere present. (auth)

14002 (UCRL-13139) VISCOELASTIC PROBLEMS IN DESIGN. Technical Report No. 2. W. N. Findley, K. Onaran, J. S. Y. Lai, C. A. Stanley, and R. M. Reed (Brown Univ., Providence. Engineering Materials Research Lab.). Sept. 1964. For Univ. of California, Lawrence Radiation Lab., Livermore. Contract [W-7405-eng-48]. 34p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A research program is being conducted to determine the relationships needed to describe the nonlinear viscoelastic behavior of solid and foam plastics. The work includes both theory to develop models and experiments to check theory. Some data are presented for the creep of polyvinyl chloride and polyurethane rigid foam under various conditions. (D.L.C.)

14003 (ORNL-tr-461) RECRYSTALLIZATION DUE TO PLASTIC DEFORMATION IN HOT WORKING. C. Rossard. Translated for Oak Ridge National Lab., Tenn., from Colloq. Met., 7e, Centre Etudes Nucl. Saclay, (Gif-sur-Yvette, France), 1963. 26p. Dep.(mn); $2.60(fs), $1.10(mf) JCL.

A description is given of the mechanical behavior of series of metals and alloys as determined by a number of investigators in tests covering the range of deformation rates and temperatures corresponding to hot working conditions. Stress-deformation curves were thus established under various conditions. During deformation at a constant true deformation rate and at constant temperature, work-hardening occurs up to a certain value of deformation which is dependent on rate and temperature. Beyond this deformation, the stress decreases, then assumes a constant value which is dependent only on deformation rate and temperature for a given metal. On the basis of these mechanical characteristics, an account is given of the structural developments observed during hot deformation. Work-hardening is accompanied by a breakup of the original grains which, with continuing deformation, either polygonize or recrystallize. The observed process seems to depend on the relative ease of climb of dislocations in the metal considered. On the level portion of the curve, the structure consists of new equiaxial grains, formed either by accentuation of the subgrain boundaries, followed by migration when the degree of disorientation is sufficient, or by extension of recrystallization throughout the matrix. The grain size thus obtained remains constant throughout this level stage and depends upon the rate of deformation and temperature. The structures thus observed do not in general remain unchanged during holding at temperature after deformation. A recrystallization is produced of which the initial appearance and subsequent progression are the more rapid, the greater the degree and rate of deformation which the metal has undergone. After a given time of holding at temperature, a critical deformation can be observed above which recrystallization takes place, with the resulting grain size being smaller, the greater the degree of and rate of deformation and the lower the temperature. (auth)

14004 THE CRYSTAL STRUCTURE OF THE HIGH TEMPERATURE FORM OF $PuGa_3$. Allen C. Larson, Don T. Cromer, and R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 18: 294-5(Feb. 10, 1965). (LA-DC-6568)

The $PuGa_3$ was prepared by arc melting and slowly cooling a stoichiometric mixture of Ga and Pu. The alloy was crushed and selected fragments were examined using a camera and a diffractometer. All fragments were found to be twinned rhombohedral crystals, with each twin making up about half of any fragment. The lattice constants were found to be $a = 6.178 + 0.001$ and $c = 28.031 \pm 0.004$ Å. It appeared probable that the $PuGa_3$ structure consisted of close-packed layers in a 12-layer stacking sequence. Structural factors are presented in tables. (M.C.G.)

14005 EFFECT OF PLASTIC DEFORMATION OF ELECTRICAL RESISTIVITY OF COLUMBIUM. D. P. Gregory (Pratt and Whitney Aircraft, Middletown, Conn.). Acta Met., 13: 135-6(Feb. 1965).

The strain-resistivity of polycrystalline bcc niobium (99.96% pure) was found to exhibit a complex behavior, which did not appear to be caused by lattice vacancies. After deforming in tension at −70°C to the desired strain at a strain rate of 0.02 min^{-1}, a specimen was unloaded to 10 lb, the cryostat was filled with liquid nitrogen, and resistance was measured after temperature equilibration at −196°C. Electric resistivity increased to 3% strain and decreased afterwards. Mechanaisms explaining these changes are discussed. (M.C.G.)

14006 ANOMALOUS TEMPERATURE DEPENDENCE OF ELASTIC MODULI OF NIOBIUM METAL. Philip E. Armstrong and Harry L. Brown (Los Alamos Scientific Lab., N. Mex.). Am. Soc. Metals, Trans. Quart., 58: 30-7 (1965). (LA-DC-6607)

An anomalous increase with temperature of Young's modulus for polycrystalline niobium was partially explained by modulus measurements on single crystals. Young's modulus for a single crystal in the [100] orientation decreased with increasing temperature, while crystals in the [110] and [111] orientations increased in modulus by up to 16% between room temperature and 900°C. The two shear constants changed with increasing temperature in such a manner that the metal became more nearly isotropic, and it was this change that produced the observed increases in elastic moduli. Thermal expansion data up to 2000°C are presented. (auth)

14007 THE EFFECTS OF A CARBON ADDITION ON THE TENSILE PROPERTIES OF W–0.35 PERCENT Ta AND TUNGSTEN SINGLE CRYSTALS. R. H. Schnitzel (Westinghouse Electric Corp., Bloomfield, N. J.). Am. Soc. Metals, Trans. Quart., 58: 74-84(1965).

The effects of a carbon addition and subsequent heat treatments on the tensile properties of W–0.35% Ta and tungsten single crystals were determined. A carbon addition had a pronounced effect on the yield strength of these crystals when quenched from 2200 or 2450°C. A maximum strengthening increment of 55,000 psi was observed at 600°C for tungsten crystals and about 45,000 psi for the W–0.35% Ta crystals. The increased strength was accompanied by a loss in ductility at about 600°C. The observed phenomenon was attributed to precipitation hardening. (auth)

14008 STAGE I RECOVERY OF DEFORMED ZIRCONIUM. M. L. Swanson, A. F. Quenneville, and H. Schultz (Atomic Energy of Canada Ltd., Chalk River, Ont.). Appl. Phys. Letters, 6: 49-51(Feb. 1, 1965).

The recovery of the electrical resistivity increment produced by plastic deformation of polycrystalline zirconium was studied. A large annealing peak was observed at 32.5°K, where 35 to 45% of the residual resistivity increment anneals out. This recovery was attributed to the movement of free interstitials with a migration energy of 0.11 ev. (D.C.W.)

14009 MAGNETIC PROPERTIES OF URANIUM NITRIDES. THE U_2N_3 PHASE OF VARIABLE COMPOSITION. W. Trzebiatowski and R. Troc (Technical Univ., Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chem, 12: 681-5(1964).

The magnetic properties of uranium nitrides exceeding $UN_{1.5}$ in nitrogen content, were examined within a phase of variable composition. With increasing nitrogen content the magnetic susceptibilities diminished and, on the basis of extrapolation, it is supposed that at UN_2 composition in the nitride phase loses its paramagnetism. The α phase containing strictly 60 at. % $N(U_2N_3)$ showed a characteristic maximum susceptibility at 96°K, which resulted from antiferromagnetic spin coupling. Thus, α-U_2N_3 differs magnetically from the β modification, which becomes ferromagnetic at 186°K. (P.C.H.)

14010 MAGNETIC PROPERTIES OF URANIUM COMPOUNDS WITH ARSENIC OR ANTIMONY. W. Trzebiatowski, A. Sepichowska, and A. Zygmunt (Inst. of Structural Research, Polish Academy of Sciences, Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chem., 12: 687-90(1964).

The magnetic properties of UAs, USb, U_3As_4, U_3Sb_4, UAs_2, and USb_2 were investigated by the Faraday method at 80 to 350°K. From x-ray analysis and magnetic measurements, it was found that compounds like UX and UX_2 are antiferromagnetic, whereas U_3X_4 compounds are ferromagnetic. The magnetic moments of the mono-compounds were distinctly larger than the other compounds, but the magnetic moments of the U_3X_4 and UX_2 arsenides and antimonides were similar. (P.C.H.)

14011 PHASES IN THE BINARY SYSTEMS PbO–La_2O_3, Gd_2O_3, AND Sm_2O_3. Madeleine H. Warzee, Marcel Maurice, Franz Halla, and Walter R. Ruston (Societe d'Etudes de Recherches et d'Applications pour l'Industrie, Brussels). J. Am. Ceram. Soc., 48: 15-17(Jan. 21, 1965).

In the binary system PbO–La_2O_3 only one compound, $4PbO \cdot La_2O_3$, exists; it is flanked by two eutectics. The structure of the compound, although of lower symmetry, is intimately related to the C modification of the rare earths. Below 800 to 1000°C, metastable solid solutions are formed from oxide mixtures coprecipitated from mixed solutions of the nitrates, the cubic parameter $\alpha = 5.66$ A, if extrapolated to pure La_2O_3, corresponding to half the α parameter

of the C form of La_2O_3. The solid solutions existing between the compositions La_2O_3-2PbO and pure La_2O_3 have a cubic face-centered lattice and obey Vegard's rule. The systems of PbO with Sm_2O_3 and Gd_2O_3 are quite similar to that with La_2O_3. The compound $Sm_2O_3 \cdot 4PbO$ decomposes at 1000°C with evaporation of PbO; Sm_2O_3 remains in the B modification. (auth)

14012 THERMAL CONDUCTIVITY OF SINTERED UO_2 AND Al_2O_3 AT HIGH TEMPERATURES. Toraji Nishijima, Toshiyuki Kawada, and Akira Ishihata (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). J. Am. Ceram. Soc., 48: 31-4(Jan. 21, 1965).

The thermal conductivities of sintered Al_2O_3 and UO_2 were measured in the ranges 400 to 1700°C and 300 to 2100°C, respectively. The conductivity values for Al_2O_3 agreed with those reported previously at all temperatures investigated. The conductivity of UO_2 decreased with increasing temperature to a minimum of 0.0050 cal per cm sec °C at about 1400°C, and then increased with increasing temperature to 0.0105 cal per cm sec °C at 2100°C. (auth)

14013 DISCONTINUOUS GRAIN GROWTH IN SINTERED UO_2. I. Amato (FIAT Sezione Energia Nuclear, Turin). J. Am. Ceram, Soc., 48: 53(Jan. 21, 1965).

The effects of organic compounds on grain growth in sintered UO_2 were investigated. Two sets of pellets were pressed to green densities of 5, 5.5, 6, and 6.5 g per cm^3 using Belgian UO_2 powder. No organic additives were used in one set; 1 wt % PVA and 1 wt % polyethyleneglycol were added to the other set. Pellets were sintered 3 hr at 1600°C in hydrogen and then given subsequent heat treatments of 3 hr at 1650, 1700, 1750, and 1800°C in hydrogen. In the pellets with no organic additive grain growth was continuous up to 1800°C and the limiting grain size was of the order of 50 μ. In the pellets with organic additives the limiting grain size for continuous grain growth was of the order of 10 μ; discontinuous grain growth started thereafter at temperatures that were lower as green density became higher. The effects caused by the organic additives are discussed. (P.C.H.)

14014 PHASE TRANSITION ON SUBMICRON PARTICLES OF ZrO_2. F. W. Vahldiek (Air Force Materials Lab., Wright-Patterson AFB, Ohio). J. Chem. Eng. Data, 10: 31-3(Jan. 1965).

Spherical submicron particles of ZrO_2 were a mixture of 50% monoclinic and 50% tetragonal ZrO_2. The metastable phase transformed to the monoclinic phase when samples were heated to 820°C for 2 hours. The transitions of the as-received ZrO_2 samples determined by high-temperature x-ray diffraction and differential thermal analysis methods were from 1000 to 1190°C (increasing temperature, endothermic) and 1040 to 300°C (decreasing temperature, exothermic). The transformations for specimens preheated to 1450°C were from 1110 to 1205°C (increasing temperature) and from 980 to 895°C (decreasing temperature). (auth)

14015 LUMINESCENCE OF EUROPIUM IN THE TERNARY SYSTEM: $La_2O_3-Gd_2O_3-Y_2O_3$. R. C. Ropp (Sylvania Electric Products Inc., Towanda, Penna.). J. Electrochem. Soc., 112: 181-4(Feb. 1965).

A detailed study of a rare-earth oxide ternary system activated by Eu^{3+} showed that these phosphors are host-sensitized. There are matrix excitation bands present as well as a band attributed to perturbation of excited states of Eu^{3+}. An exciton mechanism is believed responsible for the matrix band and the field perturbation of the excited Eu^{3+} state. (auth)

14016 ELECTRON-PROBE MICROANALYSIS OF MAGNESIUM/ZIRCONIUM DIFFUSION COUPLES. D. M. Poole, P. M. Martin, and E. N. Hodkin (Atomic Energy Research Establishment, Harwell, Berks, England). J. Inst. Metals, 93: 168(Jan. 1965).

Studies were made of magnesium/zirconium diffusion couples. Microprobe analysis determinations across the zone, corrected for x-ray absorption and for atomic-number effects, provided definite evidence for the existence of a discrete phase with composition close to 10 wt % zirconium. Concentration profiles for the two elements in a couple annealed at 623°C are given. Clear evidence of the solid solubility of magnesium in zirconium was obtained. (M.C.G.)

14017 THE DUCTILE-BRITTLE TRANSITION IN POLYCRYSTALLINE TUNGSTEN. A. Wronski and A. Fourdeux (Union Carbide European Research Associates, Brussels). J. Less-Common Metals, 8: 149-58(Mar. 1965).

The ductile-brittle transition temperature of polycrystalline tungsten was found to be ~100°C higher in sintered material than in melted material of coarser grain size and probably higher purity. Whereas the brittle fracture stress of recrystallized swaged single crystals increased with decreasing temperature, no reproducible behavior was detected on testing sintered material. Reasons for this were sought using conventional metallurgical techniques and replica and transmission electron microscopy. It is only the last of these techniques that reproducibly showed that in sintered tungsten there are small gas bubbles or voids, absent in melted tungsten. The behavior of the bubbles in the as-received (warm-worked) sintered rod was studied as the material was annealed at 1080, 1550 and 1730°C to yield the fully recrystallized state. (auth)

14018 ELECTRICAL AND X-RAY STUDIES OF SOME NEODYMIUM-DYSPROSIUM ALLOYS. S. Arajs, R. V. Colvin, and H. Chessin (U. S. Steel Corp. Research Center, Monroeville, Penna.). J. Less-Common Metals, 8: 186-94 (Mar. 1965).

Electric resistivities of neodymium and 15.9 at. % dysprosium neodymium alloy were studied from about 2 to 300°K. The resistivity vs. temperature curve for neodymium exhibited anomalies at approximately 5 and 20°K, which were associated with magnetic transformations. These transition temperatures were slightly increased by alloying with 15.9 at. % dysprosium. Hysteresis effects in the electric resistivities of neodymium and of 15.9 at. % dysprosium-neodymium alloy were complicated and could not be explained using existing theories. The lattice parameters of neodymium-dysprosium alloys, containing 0, 5.5, 11.2, and 15.9 at. % dysprosium, were determined at 295°K using samples quenched from 823°K. The size effect in the neodymium-dysprosium system was examined in terms of elasticity theory and additivity of atomic volumes. The observed change in lattice constants due to alloying at low dysprosium concentrations were smaller than those predicted by the size effect alone. (auth)

14019 SOME DILATOMETRIC OBSERVATIONS ON THE $\alpha-\beta$ TRANSFORMATION IN ZIRCONIUM-$2\frac{1}{2}$ WT. % NIOBIUM ALLOY. G. F. Slattery (Reactor Fuel Element Labs., Salwick, Preston, Lancs, Eng.). J. Less-Common Metals, 8: 195-208(Mar. 1965).

The effects of repeated heating and cooling on dilatometric curves in the region of the $\alpha \rightleftharpoons \beta$ transformation range were investigated with particular reference to the effect of oxygen contamination at reduced pressures. Data were obtained on specimen length changes, instantaneous thermal expansion coefficient, dilation change at transformation, and transition temperatures. The Goldschmidt expansion on cooling from just below the $(\alpha + \beta)/\beta$ transition in a vacuum of 2×10^{-6} mm Hg was ten times greater than when the specimen was cooled from just above this transition, while the final length change was ~1% elongation compared with ~1% contraction in the second case. Repeated $\alpha \rightleftharpoons \beta$ cycling led to a reduced dilation change and small specimen elongation. The structural implications are discussed. Oxygen contamination at 3×10^{-4} mm Hg virtually eliminated the dilation change through transformation. The mechanism of formation of horizontal portions to the cooling curve is discussed and on cooling is attributed to the interaction of the transforming outer layers with the still contracting untransformed β core region. Pressure variations in the range from $10^{-6}-10^{-4}$ mm Hg had an important influence on transition temperatures. (auth)

14020 RARE EARTH-ALUMINIUM INTERMETALLIC COMPOUNDS OF THE FORM RAl AND R_3Al_2. K. H. J. Buschow (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). J. Less-Common Metals, 8: 209-212(Mar. 1965).

Lattice constants are given for the following intermediate phases: LaAl and CeAl (CeAl type, orthorhombic); PrAl, NdAl, SmAl, GdAl, TbAl, DyAl, HoAl, and ErAl (ErAl type, orthorhombic); and Gd_3Al_2, Tb_3Al_2, Dy_3Al_2, Ho_3Al_2, Er_3Al_2, and Y_3Al_2 (Zr_3Al_2 type, tetragonal). It is shown that the stability of these compounds is sensitive to the atomic radii of the rare earth metals. (auth)

14021 THE TRANSFORMATION TEMPERATURE OF HAFNIUM. P. A. Romans, O. G. Paasche, and H. Kato (Bureau of Mines, Albany, Ore.). J. Less-Common Metals, 8: 213-15(Mar. 1965).

The high-temperature x-ray technique was used to determine the transformation temperature of hafnium. High-purity crystal bar hafnium rolled into a strip was used. The sample was heated by electric resistance in a vacuum to the transformation temperature. A value of 1777°C was obtained for the transformation temperature. (M.C.G.)

14022 CREEP OF URANIA BASE SOLID SOLUTIONS. W. M. Armstrong and W. R. Irvine (Univ. of British Columbia, Vancouver). J. Nucl. Mater., 12: 261-70(1964).

Sintered uranium dioxide specimens containing soluble additions of CaO, Y_2O_3, ZrO_2, or insoluble additions of SiO_2 were subjected to creep-in-bending tests at temperatures from 1200 to 1450°C in a dry hydrogen atmosphere. The soluble additions decreased and SiO_2 additions increased the plasticity of UO_2. Activation energies for steady state creep were determined. Grain boundary sliding and migration occurred during creep of all these materials. Additions of CaO, Y_2O_3, and SiO_2 increased the tendency towards formation of intercrystalline cracks during creep of UO_2. (auth)

14023 THE QUASI-BINARY SYSTEM UCo_2-UAl_2. Guenter Petzow, Siegfried Steeb, and Gonde Kiessler (Max-Planck-Institut fur Metallforschung, Stuttgart). J. Nucl. Mater., 12: 271-6(1964). (In German)

The constitution of the quasi-binary system UCo_2-UAl_2 was established by micrographic, thermal, chemical, and x-ray investigations. The system has a peritectic three-phase equilibrium (Melt + $UCo_2 \rightleftharpoons U_2Co_3Al$), which at 990°C extends from 4 to 13 at.% Al. This reaction produces a ternary Laves phase of C14 ($MgZn_2$) type and a composition of U_2Co_3Al. In addition, the system embodies two eutectic ternary equilibria [Melt $\rightleftharpoons U_2Co_3Al + U(Co,Al)_2$ and Melt $\rightleftharpoons UAl_2 + U(Co,Al)_2$]; these cover the ranges 17 to 31 at.% Al and 36 to 64 at.% Al at 970 and 1150°C, respectively. At intermediate concentrations a second ternary Laves phase $U(Co,Al)_2$ appears; this is of the C36 ($MgNi_2$) type and has a melting point of 1180°C. (auth)

14024 PHASE TRANSFORMATIONS AND EQUILIBRIUM STRUCTURES IN URANIUM-RICH NIOBIUM ALLOYS. C. D'Amato, F. S. Saraceno, and T. B. Wilson (SNAM, Laboratori Riuniti Studi e Ricerche, S. Donato Milanese, Milan). J. Nucl. Mater., 12: 291-304(1964).

The microstructures obtained in uranium–0.2 to 7.2 wt % Nb alloys by a variety of heat treatments commencing from the γ phase, are described. The phases obtained, and their distribution, were studied using optical and electron microscopy and x-ray diffractometry. Transformation of the γ phase above the M_s temperature resulted in two-phased structures; the lower the transformation temperature the finer the structure. The $(\beta+\gamma_1)$ and $(\alpha+\gamma_1)$ structures were obtained in their respective fields, while $(\alpha+\overline{\gamma}_1)$ structures were formed in the $(\alpha+\gamma_2)$ field. The metastable γ_1 phase decomposed by rejection of excess uranium to the equilibrium γ_2 phase on extended annealing at elevated temperatures in the $(\alpha+\gamma_2)$ field. Quenching from the $(\beta+\gamma_1)$ field produced duplex structures, both phases being α, but supersaturated to different degrees. Slow cooling from this field resulted in $(\alpha+\overline{\gamma}_1)$ structures, and the same phases occurred at room temperature independent of the method of cooling after transformation of the γ-phase in the $(\alpha+\gamma_1)$ field. The metastable phases α'_a, α''_b and retained γ were obtained depending on the niobium content, by water quenching from the γ phase. Aging of the α'_a and α''_b phases in the $(\alpha+\gamma_2)$ field resulted in typical age-hardening phenomena. The formation of the equilibrium γ_2 phase was preceded by that of the metastable $\overline{\gamma}_1$ phase. (auth)

14025 THERMAL SHOCK RUPTURE OF SOME URANIUM CERAMICS. C. Mustacchi (EURATOM, Ispra, Italy). J. Nucl. Mater., 12: 330-1(1964).

The ceramic uranium compounds UC and UO_2 were investigated from the standpoint of thermal shock fracture. The rupture stresses resulted in 3780 kg/cm² for UC and 892 kg/cm² for UO_2, in excellent agreement with reported values of static mechanical strength. (auth)

14026 SOLUBILITY OF PLUTONIUM IN LIQUID TIN. John W. Ward and Robert N. R. Mulford (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 12: 335-6(1964). (LADC-6099)

Plutonium was found to be quite insoluble in molten tin. At temperatures below 400°C, equilibrium between $PuSn_3$ and liquid was not attained. At 400°C and above, reproducible solubility values were obtained for different holding times, which were interpreted to mean that equilibrium was established. The holding times needed were quite long. A filtration technique was used in obtaining the solubility data, which are presented in graph form. (M.C.G.)

14027 THE EFFECT OF QUENCHING RATE ON THE TEMPERATURES OF THE ALLOTROPIC PHASE CHANGES IN PLUTONIUM. M. E. Faiers and J. S. White (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Mater., 13: 125-9(1964).

A gas-quenching apparatus was used to determine the temperatures of the allotropic phase changes of unalloyed plutonium, at cooling rates varying from 20 to 5000°C/sec. Helium gas was used as the quenching medium, and the cooling curves were recorded using a cathode-ray oscilloscope. The $\epsilon \rightarrow \delta \rightarrow \gamma$, the $\delta \rightarrow \gamma$, and the $\gamma \rightarrow \alpha$ transformations were independently studied. The results showed that with increasing cooling rate the temperatures of all the phase changes are increasingly depressed, thus ruling out athermal mechanisms as possible modes of transformation. (auth)

14028 SOME STRAIN AGEING—EFFECTS IN COMMERCIAL NIOBIUM. Z. C. Szkopiak and L. W. Derry (Battersea Coll. of Technology, London). J. Nucl. Mater., 13: 130-6(1964).

The effects of strain-aging on the room temperature mechanical properties and internal friction relaxation peaks due to interstitial impurities are discussed. The results showed that the strain-aging behavior of niobium is in general similar to the behavior of mild steels. The mechanism of aging is, however, different in so far as oxygen plays an important part in the aging of niobium by diffusing to free dislocations first, and then being replaced by carbon. Besides replacing oxygen at dislocations, it is suggested that carbon contributes to strain-aging by cluster formation. (auth)

14029 THE ACTIVATION ENERGIES FOR CREEP OF ZIRCALOY-2. J. J. Holmes (General Electric Co., Richland, Wash.). J. Nucl. Mater., 13: 137-41(1964). (HW-SA-3165)

The activation energies for creep of Zircaloy-2 were determined by the temperature change method. Values were obtained for stresses of 20 000, 25 000, and 30 000 psi at temperatures from 50 to 500°C. Below about 285°C the activation energy was stress, strain rate, and temperature dependent indicating that dislocation intersection or the Paerls process is controlling creep. Above about 285°C the activation energy for creep was equal to that of self-diffusion, 58 500 cal/mole, and typical of dislocation climb controlled creep. In addition an activation energy peak was observed. (auth)

14030 THE EFFECT OF BACK-PRESSURE ON THE COUNTER DIFFUSION OF GASES IN GRAPHITE. G. F. Hewitt and E. W. Sharratt (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 13: 197-206(1964). (AERE-M-1081)

Measurements are reported on the effective diffusivity of oxygen in nitrogen through the pores of various graphites

with widely different permeabilities. The effect of back purging with nitrogen was studied. A thousandfold reduction of apparent diffusivity occurred with back pressures ranging from about 3 to 720 torr according to the type of graphite. The permeability constants (B_0 and K_0) were measured and introduced into a theoretical relationship, which predicted the back diffusion data. The effect of pore structure on back diffusion and the application of the results to a type of high temperature, gas-cooled reactor are discussed. (auth)

14031 THE MIGRATION OF GAS BUBBLES IN MATERIALS SUBJECT TO A TEMPERATURE GRADIENT. M. V. Speight (Central Electricity Generating Board, Berkeley, Gloucestershire, Eng.). J. Nucl. Mater., 13: 207-9(1964).

It is shown that where gas bubbles are present in material subject to a temperature gradient, they may migrate by vapor transport of matrix material across the bubble. When the total pressure of gas and vapor within the bubble is balanced by the surface tension restraint of the surrounding matrix, the velocity of migration is proportional to the bubble radius. This mechanism is compared with bubble migration by surface diffusion of the matrix atoms surrounding them. (auth)

14032 PROPERTIES OF URANIUM DIOXIDE–MOLYBDENUM BODIES. Erich Gebhardt, Gerhard Ondracek, and Fritz Thuemmler (Max-Planck-Institut fur Metalliforschung, Stuttgart). J. Nucl. Mater., 13: 229-41(1964). (In German)

Property measurements were made on UO_2–Mo cermets. The specific electrical resistivity of UO_2–Mo green pellets and sintered pellets decreased with the molybdenum concentration. Between 30 and 40 wt % molybdenum there was a clear change in the shape of the curve. This phenomenon was attributed to the matrix change from one component to the other, which was geometrically limited. A clear discontinuity at approximately 35 wt % molybdenum is shown in the curve of the thermal conductivity vs molybdenum concentration. The thermal conductivity was improved by additions of molybdenum. The improvement amounted to 100% at a molybdenum concentration of 30 wt %. The thermal conductivity was measured at 200, 400, and 600°C. The linear thermal coefficient of expansion became smaller with increasing molybdenum concentration. The curve of the linear thermal coefficient of expansion vs concentration was not linear until approximately 25 wt % Mo (again because of the matrix change), while at higher molybdenum concentrations the curve became a straight line. The modulus of elasticity in bending UO_2–Mo cermets vs concentration showed a minimum in the range of the matrix change (30 to 40 wt % Mo). In all cases an alternate was made to interpret the course of the curves and, as far as possible, to compare with literature values. Equations were derived for the concentration dependence of the coefficient of the electrical resistivity and of the linear thermal expansion. They agreed to a certain extent with the curves. Several experiments were made on the machinability of the UO_2–Mo sintered pellets. Reactor irradiation experiments were made on UO_2–Mo sintered pellets and pure UO_2 sintered pellets. The mixed pellets were not subject to any greater alterations in properties than the pure oxide pellets. (auth)

14033 PHYSICAL PROPERTIES OF URANIUM DIOXIDE–STAINLESS STEEL CERMETS. G. Arthur and J. A. Coulson (International Research and Development Co., Ltd., Newcastle-upon-Tyne, Eng.). J. Nucl. Mater., 13: 242-53(1964).

The thermal expansion, thermal conductivity, and mechanical strength of uranium dioxide–stainless steel cermets of various UO_2 contents prepared by hot rotary swaging were measured. The thermal expansion results did not agree with those calculated using an equation of Turners for multiphase materials and this was considered to be due to lack of cohesion between the uranium dioxide and the stainless steel. The thermal conductivity results for 30 and 50 vol % UO_2 cermets, when corrected for porosity, agreed well with values predicted by Maxwell's theory. The results for a 60 vol % UO_2 cermet were considerably lower than predicted. This was thought to be due to fragmentation of the UO_2 by swaging. The variation of ultimate tensile strength with UO_2 content at both 20 and 700°C could be explained approximately by the variation in the minimum area of stainless steel supporting the applied load. At both temperatures the variation of ultimate tensile strength with UO_2 content followed a curve of the form $S = S_0 \exp(-3.8p)$, where p is the fractional UO_2 content and S_0 is 75,000 psi at 20°C and 39,400 psi at 700°C. The 0.2% proof stress per unit area of stainless steel increased with UO_2 loading. This was probably due to the presence of triaxial stresses caused by the notching effect of numerous UO_2 particles. (auth)

14034 PORE GROWTH DURING SOLARIZATION OF SINTERED UO_2. I. Amato, R. L. Colombo, and A. M. Protti (FIAT, Turin). J. Nucl. Mater., 13: 265-7(1964).

Solarization is a regression in the fired density of a sintered UO_2 body, which may occur if the firing time and/or temperature are excessive. It was found that pores representing solarization are aligned in the matrix according to a sort of three-dimensional, largely intergranular network. This pattern was preserved when the pores grew and merged together, ending up in macroscopic cavities. (M.C.G.)

14035 THE MECHANISM OF TENSILE FRACTURE IN GRAPHITE. G. M. Jenkins (Central Electricity Generating Board, Berkeley, Gloucestershire, Eng.). J. Nucl. Mater., 13: 268-9(1964).

It is shown that the Griffith crack mechanism is insufficient for explaining the tensile fracture of polycrystalline graphite and that it must be preceded by a Stroh mechanism. The Griffith theory was insufficient because the crack length was too small and the compliance governing fracture is sensitive to irradiation. (M.C.G.)

14036 THE BEHAVIOUR OF FISSION PRODUCT GASES IN URANIUM DIOXIDE. G. K. Williamson and R. M. Cornell (Central Electricity Generating Board, Berkeley, Gloucestershire, Eng.). J. Nucl. Mater., 13: 278-80(1964).

Thin slices were cut from synthetic single crystals of UO_2. Krypton ions were injected into the sample using a heavy ion accelerator. Krypton bubbles could be formed by pulse heating the sample in the electron beam of the electron microscope to temperatures where evaporation of UO_2 was rapid. On annealing the samples bubble diffusion could be observed. Mechanisms in bubble diffusion are discussed. (M.C.G.)

14037 ANISOTROPY AND THE ANOMALOUS RESISTIVITY OF ALPHA PLUTONIUM. M. B. Brodsky and L. C. Ianniello (Argonne National Lab., Ill.). J. Nucl. Mater., 13: 281-2(1964).

Resistivity and x-ray diffraction studies of alpha-plutonium are reported. The only evidence of preferred orientation from the back reflection patterns was a relative shift in the intensity of certain rings as a function of reduction. Front reflection patterns did reveal ring segmentation for samples reduced beyond 44% in thickness. The resistivity measurements were made at various directions with respect to the alpha rolling direction, and data are presented in graphs. Evidence was obtained for magnetic disorder contributions to the resistivity. (M.C.G.)

14038 SELECTIVE ATTACK OF γ PHASES IN URANIUM ALLOYS. N. Azam and M. Bouleau (CEN, Saclay, France). J. Nucl. Mater., 15: 16-22(1965). (In French)

The use of electrolytes containing various sulfites and sulfates in dilute aqueous solution resulted in very delicate anodic attack and in selective etching of γ-phase regions of different concentrations. Some examples of results obtained with various uranium-molybdenum alloys are presented and discussed. A discussion of the mode of action of the attack led to a tentative explanation of the γ-phase transformations, which occur at comparatively low temperatures during cooling after heat treatment. (auth)

14039 THE ANISOTROPY OF EXTRUDED GRAPHITE TUBES. J. C. Bokros, R. J. Price, and G. R. Tully, Jr.

(General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Nucl. Mater., 15: 33-42(1965). (GA-5102)

An x-ray diffraction method was used to construct pole figures showing the preferred orientation of crystallites in the walls of extruded graphite tubes. Crystallite layer planes tended to lie parallel to the tube wall. The edges of the planes were well aligned along the length of the tube but only roughly aligned circumferentially, except for a better-oriented "skin" at the inside and outside surfaces. This texture produced large differences in the coefficient of thermal expansion of samples cut in the radial, circumferential, and longitudinal directions. The anisotropy of the coefficients of thermal expansion caused residual stresses in the tube wall after cooling from the heat-treatment temperature. (auth)

14040 THE THERMAL EXPANSION OF PuC AND UC–PuC SOLID SOLUTION. A. E. Ogard, C. C. Land, and J. A. Leary (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 15: 43-8(1965).

Thermal expansion characteristics for arc-melted plutonium-carbon systems containing 41.1, 43.2, 44.9, 45.4, and 45.8 at. % carbon and for $U_{0.87}Pu_{0.13}C$ were determined between room temperature and 900°C. The average coefficients of linear thermal expansion for a single phase alloy containing 45.8 at. % carbon and for single phase $U_{0.87}Pu_{0.13}C$ are presented as well as results pertaining to the plutonium-carbon phase diagram. A mechanism is suggested to explain the contraction observed in the dilatometric curves for the alloys, which contained 43.2, 44.9, and 45.4 at. % carbon. (auth)

14041 AN X-RAY STUDY OF TEMPERING IN A TERNARY ZIRCONIUM MARTENSITE. D. L. Douglass (General Electric Co., Pleasanton, Calif.). J. Nucl. Mater., 15: 49-56(1965).

The stability of martensite in Zr–2Nb–2Sn, which was formed by quenching from the beta phase, was studied for times up to 2000 hours at temperatures in the range from 400 to 700°C. Both the a_0 and c_0 lattice parameters increased with tempering, following sigmoidal-type curves. Activation energy for the process was 58 kcal/mol. According to the phase diagram the compound Zr_4Sn should be rejected from the supersaturated martensite, and the a_0 parameter should increase and c_0 decrease. The observed increase in both parameters indicated that niobium precipitated with the tin, and that the compound was not the suggested Zr_4Sn. Hardness isotherms were observed, which were similar to age-hardening. Maxima were noted at 950 hours at 400°C and at 200 hours at 500°C. Over-aging occurred in less than ⅓ hour at both 600 and 700°C and was associated with coarser precipitates than in the aged condition. Fourier analysis of the broadened peaks indicated that several nonuniform microstrains existed in the lattice initially. The microstrains were increased by tempering, but some strain remained after over-aging of the martensite occurred. Retention of hardness after extensive tempering was probably due to both microstrains and the dispersed phase. (auth)

14042 POLYMORPHIC TRANSFORMATIONS IN $PuAl_3$. O. J. C. Runnalls and R. R. Boucher (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 15: 57-64(1965).

The earlier reported six-layer hexagonal configuration of the intermetallic compound $PuAl_3$ was found to be only a high-temperature polymorph with a range of stability from 1027 ± 3 to 1210 ± 3°C. The hexagonal polymorph transformed at 1210°C to cubic $PuAl_3$, a close-packed structure with stacking sequence ABCA . . . , which was stable to above 1395°C. Two lower temperature modifications were identified also. A nine-layer rhombohedral structure was stable up to 915 ± 3°C where, at a temperature coincident with the peritectic decomposition of $PuAl_4$, a transformation to a second nine-layer rhombohedral structure occurred. The latter polymorph with stacking sequence ABABCBCACA . . . transformed readily to hexagonal $PuAl_3$ at 1027°C. The only difference observed between the two rhombohedral polymorphs on single crystal and powder diffraction x-ray films was in the length of the three-fold axis with the high temperature form having an axis shorter by 0.35 ± 0.07%. The transformation from one rhombohedral polymorph to the other appeared to be a continuous one and hence unlike a classical phase change. (auth)

14043 DETERMINATION OF INTERSTITIAL LATTICE POSITIONS OF OXYGEN ATOMS WITH ELECTRON DIFFRACTION IN MONOCRYSTALLINE URANIUM DIOXIDE FILMS. S. Steeb and P. Mitsch (Max-Planck-Institut für Metallforschung, Stuttgart). J. Nucl. Mater., 15: 81-7 (1965). (In German)

Evaporated monocrystalline films of uranium dioxide displayed superstructure diffraction diagrams when they were heated up to 250 to 600°C in an electron diffraction camera and then exposed to oxygen at 10^{-3} torr pressure. Interpretation of the diagrams showed that under the specified experimental conditions a superstructure is formed, the unit cell of which contains 4 × 4 × 1 unit cells of the UO_2 structure (a = 5.47 Å). This superlattice cell with its basic 64 uranium and 128 oxygen atoms contains a further 12 oxygen atoms, so that the composition is $UO_{2.19}$. The exact positions of these additional atoms is specified, and it was concluded that during oxidation from UO_2 to $UO_{2.19}$ the additional oxygen atoms are not distributed uniformly through the lattice, but that groups of three closely neighboring atoms are formed; the balance of attractive and repulsive forces is such that the additional atoms do not lie exactly in the ideal interstitial positions. (auth)

14044 MELTING AND STRUCTURAL CORRELATIONS OF SOME THORIUM-RICH EUTECTICS. J. R. Thomson (Imperial Coll. of Science and Tech., London). J. Nucl. Mater., 15: 88-94(1965).

Thorium-rich alloys in binary systems with copper, silver, gold, iron, cobalt, and nickel were examined. Eutectics not previously reported were detected between thorium and Th_2Ag at 30 ± 1 at. % silver and 1012 ± 12°C, thorium and Th_2Au at 20 ± 1 at. % gold and 1100 ± 12°C, and thorium and Th_7Co_3 at 20 ± 1 at. % cobalt and 1100 ± 12°C. Th_7Co_3 crystallized directly from the melt at 1188 ± 12°C. The solid solubility of silver, gold, iron, and cobalt in thorium was found to be significantly lower than 2% at the eutectic or peritectic temperatures. The peritectic formation of Th_7Fe_3 was confirmed and the peritectic temperature was found to be 962 ± 12°C. The compositions of the eutectics previously reported between thorium and Th_2Cu and between thorium and Th_7Ni_3 were confirmed but the eutectic temperatures of 1037 ± 12 and 1062 ± 12°C were significantly higher than those given in the literature. Experimental evidence is presented, which suggests that this might be due to the impure nature of the material on which the earlier results were obtained. Information on thorium-rich eutectics in nineteen systems in which intermetallic compounds occur was surveyed and it is shown that, in general, the eutectic temperatures increase and the eutectic compositions become richer in thorium as the melting points of the compounds increase. Correlations between the melting points of the eutectics, electron concentration in the liquid, the crystal structure of the intermetallic compounds and the group in the periodic table to which the alloying elements belong are also pointed out. (auth)

14045 HIGH TEMPERATURE STRESS RELAXATION OF A MAGNESIUM ALLOY. G. B. Gibbs, B. J. Hodgson, and M. A. Pirie (Central Electricity Generating Board, Berkeley, Glos., Eng.). J. Nucl. Mater., 15: 95-9(1965).

The temperature and time dependence of high temperature stress relaxation in polycrystalline Magnox AL80 was analyzed. Results are described by an exponential law for relaxation creep. The parameters of this law may be interpreted according to a model of thermally activated glide in which vacancy-producing jogs are the principal obstacles to dislocation movement. (auth)

14046 STACKING FAULTS IN ALPHA URANIUM. A. G. Crocker (Martin Co., Orlando, Fla.). J. Nucl. Mater., 15: 121-4(1965).

Stacking faults in α-uranium were studied. It was as-

sumed that the stacking operators in the neighborhood of a fault are identical with those in a perfect crystal. The simplest faults were those obtained by the removal or insertion of one (001) plane. Either results in identical stacking sequences. Single faults were bounded by sessile dislocations, and double faults were bounded by glissile dislocations. (M.C.G.)

14047 THE EFFECT OF MACHINING ON THE MODULUS OF RUPTURE OF EXTRUDED AND SINTERED BeO. K. Veevers and W. B. Rotsey (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Nucl. Mater., 15: 133-4(1965).

The effects of machining on the strength in bending of BeO specimens in and "as-sintered" condition and centerless ground, extruded and cylindrically ground specimens. The mean modulus of rupture of each batch was considerably reduced after machining. It was concluded that machining introduces surface damage in the form of microcracks. (M.C.G.)

14048 THE EFFECT OF STRESS AND ANNEALING ON THE YOUNG'S MODULUS OF REACTOR GRAPHITE. E. Hall (United Kingdom Atomic Energy Authority, Culcheth, Lancs., Eng.). J. Nucl. Mater., 15: 137-9(1965).

In studies of the effects of stress and annealing on the Young's modulus of reactor graphite, specimens were stressed in compression, to levels of 1000 and 3000 psi. Their resonant frequencies were measured before and after stressing. They were then annealed, in vacuum, at increasing temperatures between room temperature and 2000°C, and their resonant frequencies measured between each temperature cycle. The modulus dropped on stressing, but after annealing to 1500°C the modulus increased by about 20% of the stressed value. After annealing to 2000°C the modulus fell sharply by 13% in the specimen stressed to 1000 psi and by 11% in the 3000 psi specimen. This decrease was also observed in the unstressed control specimen. A specimen was stressed to 3000 psi after its resonant frequency was measured. It was then re-measured as a function of time. After a sharp decrease over the first few minutes the modulus then rose steadily. After neutron irradiation both stressed and unstressed specimens had the same modulus. It was concluded that a large part of the effect is temporary and can be recovered by annealing, irradiation, or, to a lesser extent, spontaneously at room temperature. (M.C.G.)

14049 THE DIFFUSION AND PRECIPITATION OF HELIUM IN ZIRCONIUM. G. T. Murray, H. Kuzuu, and V. Klints (Materials Research Corp., Orangeburg, N. Y.). J. Nucl. Mater., 15: 140-2(1965).

Evidence of the escape of helium by diffusion from irradiated zirconium (containing 0.1 at. % boron in order to form helium) when zirconium is heated above its alpha-beta transformation temperature was obtained. Diffusion anneals were conducted in the temperature range from 600 to 1400°C. The computed diffusivities were found to be time independent above the alpha-beta transformation temperature and 5 to 12% of the total gas was released. Below the alpha-beta transformation temperature less than 1% of the total gas was released and diffusivities were time dependent. (M.C.G.)

14050 STRESS PROBLEM OF CONTIGUOUS COAXIAL CIRCULAR CYLINDERS SUBJECTED TO NON-HOMOGENEOUS TEMPERATURE DISTRIBUTION AND TO PRESSURE. A. P. Boresi (Univ. of Illinois, Urbana). Nucl. Struct. Eng., 1: 186-96(Feb. 1965).

The axially-symmetric state of stress and deformation of multilayer coaxial circular cylindrical tubes subjected to nonhomogeneous temperature distribution and to internal and external pressures is considered. The effect of axial load is also included. Such tubes are used in superheaters and evaporators of liquid-sodium-cooled reactors. The basic equations were derived by variational techniques. The theory was restricted by basic assumptions of classical thermoelasticity. The general results are shown to reduce to results obtained by Timoshenko for the single tube. (auth)

14051 EXPERIMENTAL STUDIES ON IMPACT STRENGTH OF WELD METAL OF ARC WELDING ELECTRODE FOR REACTOR PRESSURE VESSEL. Shinji Kimura (Kobe Steel Works, Ltd., Fujisawa, Japan). Nucl. Struct. Eng., 1: 251-4(Feb. 1965).

Experimental studies were carried out on the influences of Mn and Si contents on the impact strength of Mn-Si lime basis type weld metal used to manufacture the arc welding electrode for welding reactor pressure vessels of the Advanced Calder Hall type. The test results showed that it was possible to obtain the Mn-Si lime basis type weld metal with high impact strength by increasing the Mn content of weld metal in welding of heavy thick plate. (auth)

14052 ANOMALOUS TRANSMISSION OF X-RAYS IN GERMANIUM. PART II. EFFECTS DUE TO ELASTIC DEFORMATION. B. Okkerse and P. Penning. Philips Res. Rept., 18: 82-94(Feb. 1963).

The effect of elastic deformation on the anomalous transmission of Cu K_α radiation in Ge was studied. The elastic deformation of the specimens was achieved by means of a bending moment or a temperature gradient. The bending experiment did not give reproducible results. It was shown that the surface of the specimen plays a very important part. It is not necessary to postulate the presence of microstrains in dislocation-free Ge crystals, as suggested previously. The results obtained from specimens deformed by a temperature gradient were in very good agreement with the dynamic theory for deformed crystals. The value of the adjustable parameter ϕ_H obtained experimentally was in good agreement with the value calculated theoretically. (BBB)

14053 INTERNAL FRICTION CAUSED BY OXYGEN AND NITROGEN IN NIOBIUM. D. J. van Ooijen and A. S. van der Goot. Philips Res. Rept., 19: 505-19(Dec. 1964).

The internal friction of niobium wires containing both oxygen and nitrogen was measured by means of the torsion-pendulum method. It was found that after suitable heat treatment (about 1000°C) of cold-worked wires containing oxygen, part of the oxygen atoms do not contribute to the internal friction, nor to the normal Snoek peak, which is lowered, nor to the cold-work peak, which is completely absent. This is explained in terms of the formation of domains having an ordered structure of oxygen atoms. In cold-worked wires containing both oxygen and nitrogen, first the oxygen atoms were found to precipitate or segregate spontaneously at the dislocations, but after a slight increase in the temperature (up to about 400°C) they were replaced irreversibly by the nitrogen atoms. Due to an interaction between oxygen and nitrogen, the Snoek peak caused by oxygen was found to be broadened. In some cases an additional peak appeared. (auth)

14054 ULTRASONIC ATTENUATION IN SUPERCONDUCTING ALUMINUM. R. David (Rijksuniversiteit, Leiden). Philips Res. Rept., 19: 524-602(Dec. 1964).

This thesis deals with the absorption of ultrasound in superconducting aluminum. The results of measurements using longitudinal sound waves in specimens of different purity were in agreement with the theory of Bardeen, Cooper, and Schrieffer. Extrapolation led to a zero-temperature energy gap of 3.5 kT_c. The absorption of transverse sound waves can be split up into two parts: one part according to the BCS theory and one part that decreases rapidly below the superconducting transition temperature and is zero from 0.02°K below the transition temperature. This second part of the absorption is also negligibly small when the product of the wave number of the sound and the mean free path of the electrons is much smaller than unity. This was shown by experiments on specimens of different purity using sound of different frequencies. Measurements were performed on two single crystals of zone-refined aluminum with different sound-polarization directions. The value of the absorption depended on the polarization direction, but the calculated energy gap did not. Phase transitions in a very pure zone-refined aluminum single crystal were also investigated using ultrasound, in order to find out something about the propagation velocity of the phase boundaries, and the structure of the intermediate state. For the latter, measurements at different temperatures and

different frequencies were required. The experimental results for magnetic fields both parallel and perpendicular to the sound-propagation direction supported the theories of Pippard and Faber. During the transition from the superconducting to the normal phase the absorption behaved as predicted by Pippard on the basis of the eddy-current theory. A formal description is given of the transition from the normal phase to the superconducting phase. In the very pure specimen used, thin normally conducting regions were found to exist for more than twenty minutes after an external magnetic field of the order of the critical field was switched off. All transition times were much shorter for less pure aluminum. (auth)

14055 STUDY OF THE MÖSSBAUER EFFECT IN Fe–Ni 50/50 ALLOYS ORDERED BY IRRADIATION. Y. Gros and J. C. Pebay-Peyroula (Faculté des Sciences, Grenoble, France). Phys. Letters, 13: 5-6(Nov. 1, 1964). (In French)

The Mössbauer effect on ^{57}Fe was used to study two polycrystalline samples of the Fe–Ni 50/50 alloy in the form of plane discs with a diameter of 12 mm. The first was submitted to no irradiation and has a disordered structure. The second was irradiated with electrons in the presence of a magnetic field parallel to the plane of the disc and acquired a magnetic anisotropy of 1.5×10^6 ergs/cm^3. The spectra of the ordered alloy appeared as the superposition of two spectra, one coinciding with that of the disordered alloy and the other corresponding to iron atoms whose environs are ordered. The total spectrum of the ordered alloy was decomposed to evaluate for each the internal field and the quadrupole displacement. No difference of isomeric displacement was established between the two spectra. (J.S.R.)

14056 SOME EFFECTS OF OXYGEN AND NITROGEN AS IMPURITIES ON EQUILIBRIA IN THE URANIUM-CARBON SYSTEM. J. Henney, N. A. Hill, and D. T. Livey (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Brit. Ceram. Soc., 62: 955-73(Dec. 1963). (AERE-R-4176)

The uranium carbide phases that are in equilibrium with excess graphite in the temperature range 1,000–1,700°C were found to depend on the concentration of oxygen and nitrogen impurities in the specimen and hence on the furnace atmosphere during annealing. When these impurities are present (0.01–1% in the specimen), the equilibrium phases are found to be a mixture of a tetragonal UC_2 phase containing a small amount of oxygen but deficient in carbon, and a precipitate of a cubic $UC_{(1-x)}N_x$ solid solution. Reduction of the oxygen and nitrogen to a very low level (≤100 ppm) by annealing in a vacuum of $\sim 10^{-5}$ mm Hg is accompanied by a transformation to U_2C_3 and carbon showing that, in the pure U–C binary system, U_2C_3 is the stable phase in contact with graphite from 1,000–1,700°C. (auth)

14057 THE SYSTEM ERBIUM–ALUMINUM AND A COMPARISON WITH THE SYSTEM YTTRIUM–ALUMINUM. K. H. J. Buschow and J. H. N. van Vucht (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Z. Metallk., 56: 9-13(1965). (In German)

The system erbium–aluminum was investigated over the whole concentration range by means of microscopical, thermoanalytical, and x-ray diffractional methods. The existence of the intermetallic compounds Er_2Al, Er_3Al_2, ErAl, $ErAl_2$, and $ErAl_3$ is demonstrated. The symmetry of the correspondent lattices and lattice parameters were determined. The spacings and intensities obtained from powder diagrams are given. The results obtained were gathered in a tentative phase diagram. The systems erbium–aluminum and yttrium–aluminum were compared. The lattice constants of Y_2Al are given. (auth)

14058 THE PHASE EQUILIBRIA IN URANIUM–COBALT–IRON ALLOYS IN THE PARTIAL RANGE U–UCo_2–UFe_2. Guenter Petzow and Oliveira A. Sampaio (Max-Planck-Institut fur Metallforschung, Stuttgart). Z. Metallk., 56: 14-20(1965). (In German)

The system U–UCo_2–UFe_2 was investigated using metallographic, thermal, dilatometric, chemical, and x-ray methods. Isothermal sections at 750 and 700°C and four temperature-concentration sections were worked out and present a good survey of the phase spaces. A nonvariant 4-phase equilibrium was found at 730°C. U_6Co and U_6Fe, and UCo_2 and UFe_2, respectively, exhibited complete solid solubility. The solubility of ternary additions in UCo and α–U was practically zero, and in β–U and γ–U it was very small. (auth)

14059 ON THE CONSTITUTION OF SOME ALLOY SERIES RELATED TO $TiAl_3$. I. INVESTIGATIONS IN SOME T^4–Zn–Al, T^4–Zn–Ga AND T^4–Ga–Ge SYSTEMS. Aravamudhan Raman and Konrad Schubert (Max-Planck-Institut fur Metallforschung, Stuttgart). Z. Metallk., 56: 40-3(1965). (In German)

The structure of phases belonging to the $TiAl_3$ family were determined in Ti–Zn–Al, Zr–Zn–Al, Hf–Zn–Al, Ti–Zn–Ga, Zr–Zn–Ga, Hf–Zn–Ga, Zr–Zn–Ge, Ti–Ga–Ge, and Zr–Ga–Ge alloys. The following structure types were found in the order of increasing outer electron concentration: $ZrZn_3$, Cu_3Au, $ZrAl_3$, $TiAl_3$, and $ZrSi_2$. (auth)

14060 ON THE CONSTITUTION OF SOME ALLOY SERIES RELATED TO $TiAl_3$. II. INVESTIGATIONS IN SOME T–Al–Si- AND $T^{4\cdots8}$–In SYSTEMS. Aravamudhan Raman and Konrad Schubert (Max-Planck-Institut fur Metallforschung, Stuttgart). Z. Metallk., 56: 44-52(1965). (In German)

The structure of phase belonging to the $TiAl_3$ family were determined in Ti–Al–Si, Zr–Si, Zr–Al–Si, Hf–Al–Si, Mn–Al–Si, and Mn–Ti–Si systems. The following structure types were found in the order of increasing outer electron concentration: $ZrAl_3$, Ti_3Al_{23}, $TiAl_3$, $ZrSi_2$, $Zr_{1-}AlSi_{1+}$, and $ZrSi_2$. The $ZrSi_2$ type was in equilibrium with the $TiSi_2$ type. The constitution of Ti–In, Zr–In, and Hf–In alloys was also studied. (auth)

14061 PHASE DIAGRAMS FOR CERAMISTS. Ernest M. Levin, Carl R. Robbins, and Howard F. McMurdie. Columbus, Ohio, The American Ceramic Society, 1964. 603p. $18.00.

A compilation of over 2000 phase diagrams of importance to ceramic science is presented. Interpretation of the diagrams is discussed, and a selected bibliography on theory, methods, and interpretation is given. Diagrams are given for metal-oxygen systems, metal oxide systems, systems with oxygen-containing radicals, systems containing halides only, systems containing halides with other substances, systems containing cyanides and sulfides, and systems containing water. Author and system indexes are included. (M.C.G.)

14062 REFRACTORY TRANSITION METAL COMPOUNDS; HIGH-TEMPERATURE CERMETS. G. V. Samsonov. Translated by Scripta-Technica, Inc. New York, Academic Press, 1964. 226p.

Studies of refractory compounds of transition metals, carried out by both direct and indirect methods, are discussed. The high melting points, hardness, chemical stability, and electric and magnetic properties of these compounds are related to their chemical composition, crystal structure, and occupancy of electronic states. The state of the art in analysis of properties of refractory compounds is surveyed, and principles of classification of such compounds are discussed. Methods of investigation are described. A subject index is included. (M.C.G.)

14063 REFRACTORY CERAMICS FOR AEROSPACE. A Materials Selection Handbook. J. R. Hague, J. F. Lynch, A. Rudnick, F. C. Holden, and W. H. Duckworth, comps. and eds. Columbus, Ohio, The American Ceramic Society, Inc., 1964. 507p.

Data on mechanical, thermal, and physical properties of ceramic materials are presented. The data were compiled to assist in selecting and specifying one or more ceramics, which appear to fulfill the requirements of anticipated aerospace applications. Only materials with melting points above 1500°C are included, and glass, carbon, and graphite are excluded. The data are further limited to materials in which the principal crystalline phase exceeds 95% by

weight. The materials are compared by property, and detailed properties of borides, carbides, nitrides, single oxides, mixed oxides, sulfides, aluminides, beryllides, silicides, and some other intermetallic compounds are given. Considerations involved in the structural application of brittle materials are discussed. (M.C.G.)

14064 PHYSICS OF THIN FILMS. Advances in Research and Development. Volume 2. Georg Hass and Rudolf E. Thun, eds. New York, Academic Press, 1964. 452p.

A survey on thin films is presented ranging from research in the preparation, properties, and uses of thin films to methods of coating, such as cathode sputtering, chemical deposition, vapor deposition, and anodic oxidation. (D.C.W.)

14065 SOLID STATE PHYSICS. Advances in Research and Applications. Volume 16. Frederick Seitz and David Turnbull, eds. New York, Academic Press, 1964. 460p.

A review on cohesion in ionic solids and its interpretation in terms of the Born model is first presented, with consideration of ionic radii in crystals and the surface energy of ionic solids. The formation and characteristics of F-aggregate color centers in alkali halide crystals are then surveyed, and an account is given of the methods for calculating the energy levels of magnetic ions in crystalline electric fields on the basis of a point-charge ionic model of the crystal lattice. Some elastic and thermal properties of metallic and semi-metallic elements are compiled, with consideration of correlations of these properties. (D.C.W.)

14066 BEHAVIOR AND PROPERTIES OF REFRACTORY METALS. T. E. Tietz and J. W. Wilson. Stanford, Calif., Stanford University Press, 1965. 426p. $13.50.

Information on the general behavior of refractory metals and property data for unalloyed metals are included. Mechanical, oxidation, and thermal properties of Cr, Nb, Mo, Re, Ta, W, and V are discussed and tabulated. Properties of commercial refractory metal sheet alloys and cost and size availability data for commercial refractory metal sheet alloys are appended. (P.C.H.)

14067 REDKIE METALLY. (Rare Earth Metals). O. A. Songina. Moscow, Izdatel'stvo "Metallurgiya," 1964. 568p.

Data are presented on physical and chemical properties, technology, and applications of rare earth metals. (1303 references) (R.V.J.)

14068 FACTORS AFFECTING THE DUCTILE-BRITTLE TRANSITION IN BERYLLIUM. Martin I. Jacobson (Lockheed Missiles & Space Co., Palo Alto, Calif.). 36p. (CONF-729-6)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

The ductile-brittle transition in beryllium was investigated from experimental and theoretical standpoints. It was found that in commercial purity beryllium the transition can occur over a wide temperature range, depending on orientation, grain size, and thermal treatment. The aging treatment caused the precipitation of impurities from solid solution in the form of compounds, thereby purifying the matrix and increasing the capacity for slip. The principal impurity precipitated from solid solution is believed to be iron, since the compounds $Be_5(Fe,Al)$ and $Be_{11}Fe$ could be identified. The properties of as-extruded specimens at low temperature were contrary to expected behavior in that the longitudinal specimens failed prematurely by twinning, leading to low strength and ductility. Aging resulted in significant improvements in low temperature strength, apparently by reducing the tendency to twin. The ductile-brittle transition was examined, and an attempt was made to explain the transition as being due to the thermally activated cross slip of dislocations from the basal plane into a prismatic or pyramidal plane. The proposed theory was in reasonable agreement with the experimental facts. (P.C.H.)

14069 DISLOCATIONS IN DEFORMED BERYLLIUM SINGLE CRYSTALS. V. V. Damiano and M. Herman (Franklin Inst. Labs., Philadelphia). 33p. (CONF-729-17)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

High purity beryllium single crystals were deformed in tension for basal and for prism slip. Some of the work hardening mechanisms operating at various stages were deduced from observations of dislocations in foils cut from the bulk crystals and from slip lines observed on the surface. Observation of long edge pairs and edge dipoles in foils cut from crystals deformed in stage I for basal slip suggest that screws have high mobility on the basal plane in stage I and the crystals exhibit very little hardening. In stage II the presence of numerous edge boundaries was associated with the onset of a rapid rate of work hardening just prior to failure. Three stages of hardening were observed for crystals deformed for prism slip. In stage I the observation of a predominance of screw dislocations suggested that screw dislocation intersections with the grown in networks had to occur producing jobs in the screws which acted to impede the motion of the screw dislocations. In stage II complex interactions produced complicated tangled masses of dislocations. In stage III the onset of duplex slip produce stable low angle boundaries as a result of dislocation interactions along intersections of glide planes. (auth)

14070 ELECTRON BEAM VAPORIZATION OF BERYLLIUM. M. J. Hordon and W. T. Hess (Alloyd General Corp., Cambridge, Mass.). 31p. (CONF-729-15)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

Substantial reductions in impurity contents generally present in beryllium were obtained using a vacuum distillation process involving crucible-free melting and evaporation by electron beam techniques. Analytical results showed that the concentration of impurities such as Cu, Ni, C, and O were reduced by a factor of 2 to 5. Other impurities were affected to a lesser extent. It was found that distillate purity was markedly influenced by the purity of the source material and the rate of mass evaporation. The best results were obtained using a pre-distilled source with deposition rates up to 55 g/hr. (auth)

14071 FATIGUE STUDIES OF SINGLE CRYSTAL BERYLLIUM. J. F. Breedis, A. Lawley, and J. A. Zeiger (Franklin Inst. Labs., Philadelphia). 27p. (CONF-729-14)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

Transmission electron microscope studies were made of the dislocation arrangements in zone-refined Pechiney beryllium oriented for basal or prism slip following fatigue at room temperature. Fatigue modes include reverse bending at 1800 cpm, low frequency (~ 2 cpm) uniaxial tension, or compression cycling. The surface slip structure in bend fatigue was examined optically and also by using high resolution silicon monoxide replicas. Crystals oriented for basal slip in bend fatigue do not develop a persistent slip structure at the surface. However, in the case of prism slip, additional deformation takes place by cross-slip on the basal plane, and persistent slip bands are observed below the surface. These bands consist of intrusions and extrusions. After reverse bending the surface layers show a high density of small circular prismatic loops ~ 250 Å, and bundles of dislocations elongated in the $[0\bar{1}10]$ direction. Axial fatigue gives rise to a relatively uniform dislocation substructure of edge and screw components and prismatic dislocation loops. After prolonged examination in the electron microscope, bend fatigue crystals recover by a combination of prismatic glide and climb of prismatic loops. In order to promote recovery following axial fatigue, it is necessary to heat the foil to a temperature in the range 100–200°C. The dislocation loops formed by fatigue damage or by recovery have a Burgers vector out of the plane of the loop. (auth)

14072 DIMENSIONAL STABILITY AND THERMAL EXPANSION CHARACTERISTICS OF BERYLLIUM. C. G. Jennings, A. G. Gross, Jr., and L. E. Colteryahn (North American Aviation, Inc., Anaheim, Calif.). 16p. (CONF-729-13)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

Several forms of beryllium were evaluated for thermal expansion characteristics in the temperature range of −50 to +150°C using resistance strain gages. These forms include: cast; hot-pressed; powder forged; isopressed; and hot-pressed and forged. The cast, hot-pressed, and isopressed forms were found to be nearly isotropic. The wrought forms were found to be anisotropic in varying degrees. This anisotropy was attributed to a highly developed preferred crystallographic orientation so as to cause the aggregate to behave anisotropically. The degree of anisotropic thermal expansion ranged from 0.05 ppm/F (average coefficient = 6.4 ppm/F) for some hot-pressed beryllium to 1.15 ppm/F for heavily worked forged beryllium. (P.C.H.)

14073 THE CRYSTALLOGRAPHY OF BERYLLIUM SHEET. A. G. Gross, Jr. (North American Aviation, Inc., Anaheim, Calif.). 25p. (CONF-729-12)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

A review is presented on the ductility of beryllium sheet and suggestions are made for possible solutions in improving this property of beryllium sheet. Special attention is given to the effects of crystallographic orientation on mechanical properties of beryllium sheet. It was previously indicated that three variables are important in the control of thickness-direction ductility in beryllium sheet. These variables are preferred orientation, chemical purity (and/or impurity distribution), and grain size. It is suggested that the problem of grain size control might be overcome through powder-metallurgy techniques. (P.C.H.)

14074 A_6B_{23}-TYPE COMPOUNDS BETWEEN Mn AND THE LANTHANIDE ELEMENTS; SIZE FACTOR LIMITATION DUE TO THE "ENVELOPING EFFECT." Frederick E. Wang and James R. Holden (Naval Ordnance Lab., White Oak, Silver Spring, Md.). 24p. (CONF-640702-5)

From American Crystallographic Assn. Annual Meeting, Bozeman, Mont.

Through both single crystal and powder x-ray diffraction methods, ten A_6B_{23}-type compounds were confirmed to exist between lanthanides (A) (plus Sc and Y) and manganese (B); A = Y, Nd, Sm, Gd, Tb, Dy, Ho, Er, Tm, and Lu. The formation of a compound of this type is shown to be extremely atomic size sensitive; hence it can be classified as a "size factor" compound. The "Enveloping Effect," a geometrical consideration observed in its crystal structure, is proposed as the reason for the A_6B_{23}-type compound being size sensitive, and the range of its atomic radius ratio, R/r, being well limited. (auth)

14075 COLLECTIVE ATOMIC MOTIONS IN LIQUID ALUMINIUM STUDIED BY COLD NEUTRON SCATTERING. K. E. Larsson, U. Dahlborg, and D. Jovic (Royal Inst. of Tech., Stockholm and Aktiebolaget Atomenergi, Stockholm). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/37, 37p. (CONF-804-10)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The neutron spectra scattered inelastically from polycrystalline and liquid Al were studied by the cold-neutron technique. The polycrystal was kept at 630°C and the liquid at 677°C. It is found that the approximate cross section formulas based on the harmonic approximation but including the effect of coherence relatively well describe the high-temperature results of the solid phase. The liquid scattering picture shows very strikingly the same characteristics as the polycrystalline one. Particularly, it is observed that a low frequency cut-off exists in the liquid scattering picture, which may be understood only on the assumption of the existence of collective scattering from the liquid. The results imply that at least over a region of dimensions of a few Ångströms a considerable local order is maintained for such a length of time that vibratory motions can develop. The results thus demonstrate the existence of a frequency spectrum for the liquid atomic motions consisting of two parts of different nature, one of transversal nature, the other of longitudinal nature. The results also indicate that the greatest difference between the liquid-state frequency spectrum and the spectrum for the room temperature solid state differ most markedly from each other in the high-frequency region, a region within which the shortest range order is of decisive importance. On the other hand the difference between the frequency spectra in the high-temperature solid and in the liquid differ only very slightly. The results imply that the diffusion in liquid Al is a slow process with a delay or relaxation time probably of the order of 10^{-12} seconds or greater, a result already obtained for other liquids by the neutron scattering technique. (auth)

14076 BERYLLIUM-RICH END OF FIVE BINARY SYSTEMS. M. I. Jacobson and M. L. Hammond (Lockheed Missiles & Space Co., Palo Alto, Calif.). 20p. (CONF-729-18)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

Portions of the beryllium-rich and of the binary systems of beryllium with silver, aluminum, chromium, copper, and iron are being investigated to determine more accurately the limits of terminal solid solubility and the boundaries of compound areas. The nature, structure, and appearance of second-phase particles commonly observed in beryllium microstructure are also being studied. Data are presented for the beryllium–copper alloy. (M.C.G.)

14077 THEORETICAL ASPECTS OF PHONON DISPERSION CURVES FOR METALS. W. Cochran (Univ. of Edinburgh). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/53, 33p. (CONF-804-3)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Recent theoretical work than has a bearing on the calculation of phonon dispersion curves for metals and the explanation of the long range of the interatomic potential is reviewed. The "method of neutral pseudo-atoms" for treating atomic interaction in metals is outlined, and its relevance to Kohn anomalies in phonon dispersion curves is discussed. Experimental data for Na are consistent with the theory, and the interatomic potential in Na varies periodically in a distance π/k_F, where $\hbar k_F$ is the Fermi momentum. The more exact calculations by Sham and Toya for Na are then considered. (D.C.W.)

14078 ELECTRON-PHONON INTERACTIONS AND LATTICE DYNAMICS. T. Toya (Hokkaido Univ., Sapporo). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/61, 26p. (CONF-804-5)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The contribution from valence electrons to the adiabatic potential of normal vibrations (ion-electron-ion potential) is formulated, using a variation method; and exchange and correlation effects on the effective electron-phonon interaction and the ion-electron-ion potential are studied. The theoretical results are verified by the experimental results for Na. The exchange potential for Cu is obtained from the dispersion relation of Cu. The effect of band structure on the dispersion relation of multivalent metals is investigated by calculating it for a metal with triply degenerate bands and a quasi-free electron per atom. (D.C.W.)

14079 INELASTIC NEUTRON SCATTERING FROM DOPED GERMANIUM AND SILICON. G. Dolling (Atomic Energy of Canada Ltd., Chalk River, Ont.). Vienna, International Atomic Energy Agency, 1964, Preprint No. SM-58/7, 16p. (CONF-804-23)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The normal modes of vibration of the pure semiconductors Ge and Si have been extensively studied by means of coherent one-phonon scattering of slow neutrons from single crystal specimens. Similar experiments performed on germanium heavily doped (~0.1%) with As and Ga, and also on Si doped with P. In each case, control experiments were performed on high-purity crystals. All measurements

were performed with the triple-axis crystal spectrometer at CRNL. The elastic constant C_{44} for Ge is known to be appreciably dependent on the dopant concentration, and so certain transverse acoustic (TA) modes of long wave-length were studied to see if such effects persisted into the dispersive region. Other TA modes whose frequencies could be measured with high precision were also studied in both materials to check as sensitively as possible for small effects which might be ascribed to the existence of excess electrons or holes. A particularly careful study was made of modes having the following wave vectors ($\vec{a}q/2\pi$, where a is the cubic unit cell side): in Ge, (1,0,0); in Si, (0.85, 0.85, 0) and (0.3, 0, 0). Such normal modes might be expected to show anomalous behavior in the n-type crystals, since inter-valley scattering of electrons between adjacent conduction band minima would require their co-operation in order to conserve "crystal momentum." The results in all cases were negative—no differences in phonon frequencies or energy widths between pure and doped specimens were observed within the experimental accuracy. In the most favorable cases, this (relative) accuracy is about 0.5% in frequency, rising to 1.5% for certain longitudinal optic modes in Si. (auth)

Radiation Effects

Refer also to abstracts 13985 and 14828.

14080 (AECL-2143) THE LONGITUDINAL AND DIAMETRAL EXPANSIONS OF UO_2 FUEL ELEMENTS. M. J. F. Notley, A. S. Bain, and J. A. L. Robertson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 1964. 25p. Dep.; $1.00(AECL).

The longitudinal and diametral expansions of UO_2 fuel elements irradiated in water-cooled loops are analyzed. A simple model, which gives satisfactory agreement with experimental observation, is proposed. The UO_2 pellets are considered as having a plastic core surrounded by a cracked, but rigid annulus. The extent of plasticity is governed by the temperature of the UO_2, the stress imposed on it by sheath strength and the coolant pressure, and is a function of time. Since the cracked, non-plastic annulus is rigid under compression, its longitudinal expansion can strain the sheath. Provision of a void space at the end of the pellet stack is only effective in reducing sheath strain if the pellets are free to slide relative to the sheath (i.e. where fuel-sheath contact pressures in the radial direction are low). Provisions of distributed longitudinal clearance, either as clearance between the pellets or as pellet end-face dishing, is effective in reducing sheath elongation. End-face dishing results in the point of contact between adjacent pellets being near the surface (the low temperature region) of the pellet, and also provides a void space to accommodate the expansion of the plastic core of the pellet. Diametral sheath expansion is caused by the expansion of the non-plastic ring of UO_2, plus the expansion of the plastic core. Central melting of the fuel causes additional volume expansion of the core, with correspondingly increased diametral expansions. If there is sufficient internal voidage in pellet end-face dishing or possibly as pellet porosity, the expansion of the plastic core can be accommodated and the diametral expansion of the fuel element correspondingly reduced. However, the rate of increase of element power during startup would have to be low if there were to be significant densification before maximum sheath strain occurred.(auth)

14081 (ATD-P-64-50) RADIATION DAMAGE IN SOLIDS. COMPILATION OF ABSTRACTS. Surveys of Soviet-Bloc Scientific and Technical Literature. Report No. 1. (Library of Congress. Aerospace Technology Div., Washington, D. C.). Aug. 18, 1964. 48p. (AD-604341). $2.00(OTS).

A total of 46 abstracts is presented which are arranged under the following headings: semiconductors (Si, Ge, CdS, CdSe, InSb, and GaAs), ionic crystals (alkali halides, and magnesium and zinc titanates), other materials, and theory. (D.L.C.)

14082 (EUR-1752.e) RELEASE OF XENON FROM POLYCRYSTALLINE URANIUM MONOCARBIDE (RARE-GAS DIFFUSION IN SOLIDS 17). P. Schmeling (Hahn-Meitner-Institut für Kernforschung, Berlin). 1964. 46p. Dep.(mn).

Polycrystalline uranium monocarbide samples of four different materials were investigated and the release of xenon was studied in a number of postirradiation experiments. The material was prepared by four different manufactures and included hyper- as well as hypo-stoichiometric compositions. Micrographic studies and BET measurements indicated a large specific surface. Non-ideal gas release was observed in nearly all cases. An initial burst of activity was probably due to the liberation of recoil-induced xenon. A solid-solid reaction between specimen and container material was observed in some cases and caused an enhanced gas release. The compatibility of uranium monocarbide with various high temperature materials was studied in order to minimize this effect. The diffusion coefficient was found to differ within each group of material, and a number of experiments was performed in order to show the fluctuations. The diffusion coefficients for all investigated materials appeared to fall within the same region, and all investigated materials had approximately the same diffusion coefficient at the same temperature, the fluctuations between the groups were less than the variation within each group. The activation energy for xenon diffusion showed little variation between the groups with a mean value of 67 kcal/mole and an estimated probable error of ±12 kcal/mole. It was pointed out that a comparison with other investigators has to take into account the different methods of evaluation, notably the estimation of the surface-to-volume ratio, and that this may lead to differences in the diffusion coefficient of many orders of magnitude. (auth)

14083 (HW-81602(p.3.1-7)) IRRADIATION BEHAVIOR OF CERAMIC FUELS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Two plutonium cermets, PuN–W and PuN–Pu, are being examined after burnups of 13×10^{20} and 22×10^{20} fissions/cm^3, respectively. The second of a series of three irradiation capsules of UN–20 wt % PuN is being examined after removal from the MTR at an exposure of $\sim 5 \times 10^{20}$ fissions/cm^3. Comparison of the structures formed during irradiation indicate that appreciably higher power generation rates are required in ThO_2–2.23 wt % PuO_2 and ThO_2–5.47 wt % PuO_2 in order to produce structural changes comparable to those in UO_2. The effects of decreased thermal conductivity and increased self-shielding associated with increased PuO_2 concentration are also apparent. Postirradiation examination of a thoria powder element indicates that nitrate impurity is not a limiting factor in the fabrication. No sintering was observed on a thoria element irradiated to an exposure of 3.0×10^{20} nvt. (auth)

14084 (HW-81984(p.8.1-3)) IRRADIATION EFFECTS ON MATERIALS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

In-reactor mechanical properties of stainless steel, and Zircaloy-2 were tested, and aspects of irradiation facility operation are reported. Irradiations of Hastelloy X-280 and Inconel X-750 are also reported along with results of fracture tests on irradiated Zircaloy-2. Plastic deformation in Fe was studied along with irradiation swelling of fissionable materials. (J.R.D.)

14085 (HW-SA-3664) DIMENSIONAL STABILITY OF LOW-PERMEABILITY GRAPHITES DURING HIGH-TEMPERATURE IRRADIATION TO HIGH EXPOSURES. R. E. Dahl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 8, 1964. Contract AT(45-1)-1350. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Experiments were conducted to determine the irradiation stability of low-permeability graphites (HX-10, HX-12, and EYX-60) relative to nuclear grade graphites (CSF and TSF). Irradiations were carried out in MTR and ETR at temperatures up to 1150°C. The results indicate that furfuryl alcohol binder has little effect on the stability, and that the low-permeability graphites, except EYX-60, con-

tract comparably to CSF. The effects of coke changes in CSF and TSF are also discussed. (D.L.C.)

14086 (N65-13446) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Progress Report No. 15, July 1964–September 1964. (Lockheed-Georgia Co., Marietta, Ga.). Contract NASw-114. 34p. (ER-7604). $2.00(OTS).

In-pile and out-of-pile screening tests on stainless steels and nickel alloys continued. Post-irradiation metallographic analyses were conducted. Thirty smooth and twenty-two notched tensile specimens were irradiated at 30°R. A new design was completed for transfer of the cask through the airlock penetration of the containment vessel. The refrigeration system expansion engines were disassembled, cleaned, and rebuilt following a test abort due to an expansion engine failure. (N.W.R.)

14087 (NAA-SR-8955) THE NAA 47 U–10 Mo FUEL IRRADIATION PROGRAM FOR HNPF CORE I. A. R. Schmitt, R. M. Willard, and D. K. Magnus (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1965. Contract AT-11-1-GEN-8. 44p. Dep.; $1.50(OTS).

A fuel irradiation program was conducted to investigate and define the behavior of U–10 Mo fuel at the temperatures and fission rates anticipated in Hallam Nuclear Power Facility (HNPF) Core I. Each of the eight irradiation tests contained nine 0.5-in. diameter, 2.0-in. long, cast U–10 Mo fuel specimens, NaK bonded in a double-walled stainless steel capsule. Initially the fuel specimens were either as cast, partially transformed ($\alpha + \gamma' + \gamma$), or homogenized ($\gamma$). The experiments were irradiated in the Materials Testing Reactor, for periods up to 3 years, to achieve substantial burnup levels at the relatively low Core I burnup rates, and then were disassembled and examined. Only the low-burnup specimens in Experiments NAA 47-1 and NAA 47-7, and the top specimens in certain other capsules, were relatively stable. Most of the higher-burnup fuel specimens swelled excessively at temperatures from 800 to 1300°F and fission rates from 0.3 to 1.4×10^{13} fissions/cc-sec. Imprints of thermocouple and spacer wires on the surfaces of the fuel indicated low in-pile strength and radiation-induced plasticity. Some axial surface cracking was observed. The NaK bond had extensively permeated the highly swelled fuel. Post-irradiation metallographic studies were made to investigate the phase stability of U–10 Mo irradiated at fission rates $<1 \times 10^{13}$ fissions/cc-sec and temperatures <1100°F. At higher temperatures (900 to 1000°F), the transformation products were found to be in a spheroidal form. At intermediate temperatures (~850°F), the specimens had a lamellar transformed ($\alpha + \gamma'$) microstructure. At lower irradiation temperatures, the specimens displayed a γ-phase structure. Many of the specimens, irradiated at temperatures >875°F, showed intergranular cracking. The results from these irradiations, at fission rates $<1 \times 10^{13}$ fission/cc-sec and temperatures <1100°F, extended the findings of previous investigations, conducted at fission rates from 2 to 7×10^{13} fissions/cc-sec. Fuel instability is attributed primarily to the effects of continuous in-pile phase transformation, which occurs at fission rates insufficient to retain the metastable γ phase at temperatures <1100°F. This instability appears to be most severe at intermediate temperature levels, from 800 to 1000°F. Extrapolation of test capsule data, to predict power reactor fuel element behavior, involves considerable uncertainty. The variation in irradiation conditions and the large number of severe thermal cycles, associated with as much as 3 years of irradiation, may have had a significant influence on the observed instability. As a result of the NAA 47 studies, the peak allowable burnup for HNPF Core I was substantially reduced from earlier estimates, to ~4000 Mwd/MTU, to insure that fuel rod integrity, as limited by internal fuel rod pressure, would be maintained throughout the core life. (auth)

14088 (NAA-SR-8956) IRRADIATION SWELLING, PHASE REVERSION, AND INTERGRANULAR CRACKING OF U–10 wt.% Mo FUEL ALLOY. R. M. Willard and A. R. Schmitt (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1965. Contract AT(11-1)-Gen-8. 33p. $0.75(OTS).

A fuel development program has been conducted, to investigate the behavior of U–10 wt % Mo alloy at the fission rates and temperatures anticipated in Core I of the Hallam Nuclear Power Facility. Unrestrained samples, 0.5 in. in diameter by 2.0 in. long, were irradiated in the Materials Testing Reactor for periods up to three years, to achieve substantial burnup levels at the relatively low Core I burnup rates. The specimens were irradiated in the fission rate range from 2.5 to 8.0×10^{12} fissions/cc-sec, at average central temperatures from 750 to 1085°F. Initially, the fuel specimen structures were as-cast (inhomogeneous γ), partially transformed ($\alpha + \gamma' + \gamma$), or homogenized ($\gamma$). An almost linear relationship between swelling and burnup was obtained in the burnup range from 3000 to 12,000 Mwd/MTU. Deviations from this relationship are attributed to abnormal temperatures during irradiation and/or mechanical instability. Eleven specimens from four irradiation capsules were examined metallographically. All specimens exhibited some degree of phase transformation, when compared to pre-irradiation structures. The observed structures are in good agreement with the theoretically predicted in-pile transformation of U–10 Mo as a function of burnup rate and temperature. Five of the specimens exhibited grain boundary void formation and intergranular cracking. The remaining six specimens showed no evidence of void formation or cracking. (auth)

14089 (NRS-26) POSITRON LIFETIMES IN NEUTRON- AND GAMMA-IRRADIATED POLYMERS. J. H. Green and S. J. Tao (New South Wales Univ. of Technology, Kensington). 1964. 9p. Dep.(mn).

Positron lifetimes in neutron- and gamma-irradiated solid polymers of the degrading and cross-linking type, teflon and polyethylene, were measured. Variations in lifetimes and intensities of the short and long components of the ortho-positronium lifetime are qualitative indicators of the degree of crystallinity and free radical production in the polymers. In polyethylene, τ_2 decreases rapidly as cross-linking increases with small doses, especially of neutrons; I_2 decreases quite slowly as the solid becomes more amorphous. In teflon, radical production following chain scission leads to a rapid decrease in I_3 due to conversion of ortho-positronium and an increase in the ratio $I_2/I_2 + I_3$ indicates increasing crystallinity. (auth)

14090 (ORNL-3589) GAMMA RADIATION DAMAGE AND DECONTAMINATION EVALUATION OF PROTECTIVE COATINGS AND OTHER MATERIALS FOR HOT LABORATORY AND FUEL PROCESSING FACILITIES. G. A. West and C. D. Watson (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 41p. Dep.; $2.00(OTS).

Protective coatings and other plastic materials were evaluated by irradiation in a gamma source and by decontamination tests as an extension of previous tests and for possible use in hot laboratories and fuel processing facilities and other process environs at Oak Ridge National Laboratory. Materials used may be subjected to gamma exposures of 10^4 to 10^5 r/hr and neutron exposures of 4.2×10^4 to 2.1×10^5 neutrons/cm²/sec. Epoxy, modified phenolic, and inorganic zinc protective coatings were superior to the other generic types tested in radiation environments. Exposure to radiation in the presence of water decreases the serviceable life of organic coatings about 50%. For example, the best coating, epoxy, was found to be serviceable in water exposure up to about 5×10^9 r and in air, surprisingly, up to 1×10^{10} R. Vinyls and glossy epoxies were superior to the other coatings in decontaminability. Among a group of miscellaneous materials tested, a nonmetallic plastic heat transfer compound was unaffected at 1×10^{10} R exposure in air. (auth)

14091 (TID-21625) RADIATION EFFECTS IN SOLIDS. Report for the Period, April 1, 1964–March 31, 1965. D. A. Wiegand and Julius Ashkin (Carnegie Inst. of Tech., Pittsburgh). Jan. 29, 1965. Contract AT(30-1)-3033. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Investigations of the general types of point defects pro-

duced by x-irradiation have continued with particular emphasis being placed on distinguishing between Schottky and Frenkel disorder. The characteristics of the defects produced and the mechanisms of production are studied. Electronic properties of defects produced by irradiation are discussed. The interaction of dislocations with change defects is analyzed. (N.W.R.)

14092 (FTD-TT-64-591) EPR-SPECTRA OF GAMMA-BOMBARDED QUARTZ CRYSTALS ACTIVATED WITH GERMANIUM. S. V. Starodubtsev and Sh. A. Vakhidov. Translated from Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 46-50(1963). 9p. OTS.

The paramagnetic resonance method was used to study radiation defects in Ge-activated quartz crystals which were irradiated by gamma rays. The effects of annealing and sectorial heterogeneity of the crystal on the spectra were studied. Electro treatment was carried out using graphite and NaCl electrodes, and the spectral changes were studied. (D.L.C.)

14093 ELECTRICAL RESISTIVITY CHANGES CAUSED BY RADIATION-GENERATED CASCADES OF DISPLACED ATOMS. A. Corciovei and A. Babcenco. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 5-9(1964). (In Rumanian)

Using the formula derived by J. B. Gibson (J. Phys. Chem. Solids 1: 27-34(1965)) based on the Nordheim approximation, the resistivity changes of a metallic specimen were obtained by taking into account its volume, the electron velocity corresponding to the Fermi surface, the propagation vectors, and the angle enclosed by them. From these considerations, it was concluded that the radiation-induced resistivity changes in metals are due to the formation of interstitital atom and vacancy cascades and may be expressed as the sum of the resistivity changes caused by each of the cascades. It was assumed that the irradiation is not too intense, so that the cascades of displaced atoms are not too far from each other to prevent their interaction. (TTT)

14094 ON THE INTERRUPTION YIELD POINT OF IRRADIATED ALUMINUM SINGLE CRYSTALS. Kanji Ono and M. Meshii (Northwestern Univ., Evanston, Ill.). Acta Met., 13: 140-2(Feb. 1965).

Aluminum single crystals of 99.999% initial purity were irradiated at about 86°K with electrons having an incident energy of 1 Mev to a total dose of 5×10^{17} e/cm^2. The specimens were slightly deformed in tension before irradiation and the stress-strain relation was recorded. Following irradiation the tensile test was resumed and was interrupted after a shear strain of 0.7%. The interruption was carried out at a test temperature of 77°K under stress for times ranging from 5 sec to 5 min. The unloading during the interruption was about 20%. When an interruption time of more than 1 min was employed for irradiated crystals, the stress-strain curve did not return to the extrapolated curve. Instead, a permanent increase in the flow stress level was observed. Strain-aging kinetics are discussed. (M.C.G.)

14095 MEASUREMENTS OF ENERGY RELEASED DURING ANNEAL OF SAMPLES OF VERY PURE ALUMINUM COLD WORKED OR IRRADIATED AT 78°K AND COMPARISON WITH THE VARIATION OF ELECTRIC RESISTIVITY. Emmanuel Bonjour, Colette Frois, and Omourtague Dimitrov (Centre d'Etudes Nucleaires, Grenoble, France and Centre d'Etudes de Chimie Metallurgique, Vitry, France). Compt. Rend., 259: 4027-30 (Nov. 30, 1964). (In French)

The utilization of a thermal analysis device adapted to low temperatures made it possible to refine the behavior of anneal curves, determined by measurement of the electric resistivity. It also furnished quantitative data on the phenomena produced in aluminum rolled or irradiated by neutrons at 78°K. (tr-auth)

14096 RADIATION EFFECTS IN REACTOR FUEL ELEMENTS AND REACTOR CONSTRUCTION MATERIALS. A. C. Winther (Metallurgiafdelingen, Riso, Denmark). Ingenioeren, 73: 745-50(Dec. 15, 1964). (In Danish)

With the construction of hot cells at Riso investigations could be undertaken on the effects of radiation on various materials. The types of studies being made on radiation effects in reactor fuels and reactor construction materials and the first results obtained are indicated. (J.S.R.)

14097 REDUCTION OF FISSION-PRODUCT SWELLING IN URANIUM ALLOYS BY MEANS OF FINELY DISPERSED PHASES. D. Kramer, W. V. Johnston, and C. G. Rhodes (North American Aviation Science Center, Canoga Park, Calif.). J. Inst. Metals, 93: 145-52(Jan. 1965).

Uranium-4% molybdenum-0.1% silicon and uranium-10% molybdenum-0.04% tin alloys containing finely dispersed phases were irradiated to a burnup of 0.4 to 0.6 at. % at ~300°C. Swelling was produced; it was least marked in samples having the finest dispersions, 10^{12} to 10^{13} particles/cm^3, and binary control samples containing no dispersions experienced volume increases more than ten times that of equivalent samples with dispersions. The greatly improved swelling resistance of the samples with fine dispersions appeared to result from the interaction of gas atoms with the original precipitates and with new precipitates produced during irradiation. (auth)

14098 THE CONTRIBUTION OF HELIUM BUBBLES TO THE EXPANSION OF NEUTRON-IRRADIATED BeO. H. J. Woollaston and R. S. Wilks (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 12: 305-9(1964). (AERE-R-4560)

Helium bubbles were seen by electron and optical microscopy in Milford Haven BeO irradiated to about 4×10^{20} nvt ($\geq$1 Mev) at 1000°C and the effect of post-irradiation annealing on them was studied. The volume expansion caused by these bubbles was determined, and is smaller than the observed macroscopic expansion. It was concluded that both the helium bubbles and the dislocation loops that are also present make a significant contribution to the expansion. (auth)

14099 DYNAMIC EQUILIBRIUM BETWEEN EJECTION AND RE-EJECTION OF URANIUM BY FISSION FRAGMENTS. M. D. Rogers (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 12: 332-4(1964). (AERE-R-4519)

Ejection of uranium by fission fragments from a thick uranium emitter did not stop at the neutron dose at which a single collector holds the maximum deposit. Re-ejection by fission fragments originating in the collected material occurred at a rate 1000 times less than the rate of ejection from the emitter. An early state of dynamic equilibrium between ejection and re-ejection was found to be caused by bombardment of the collector by fission fragments escaping from the surface of the uranium emitter. An average fission fragment originating in the collected material was found to re-eject ~10000 atoms (whereas one originating in the emitter re-ejected only ~1000 atoms). Fission fragments originating in the collected material were ten times more efficient in causing mass transfer than those originating in the emitter. It was concluded that this may be due to differences in the nature of the collected material and the uranium emitter. (auth)

14100 VACANCY LOOPS IN IRRADIATED AND ANNEALED GRAPHITE. M. Heerschap and P. Delavignette (SCK–CEN, Mol, Belg.). J. Nucl. Mater., 12: 349-54 (1964).

Natural graphite single crystals were reactor-irradiated up to a dose of a few times 10^{20} nvt at a temperature below the Wigner release peak. Annealing at temperatures between 1700 and 3000°C was performed in a graphite crucible in a high-frequency furnace. The specimens, obtained by cleavage of the irradiated crystals, were examined for vacancy loops by means of electron microscopy. Interstitial defects disappeared on annealing at 1700°C and small loops appeared. The radius of these loops increased up to 2600°C annealing temperature and then remained constant. It was concluded that the basal components of the Burgers vectors of all the loops or at least of most of them are in the same direction. (M.C.G.)

14101 SWELLING IN ALPHA-URANIUM DUE TO IRRADIATION IN THE RANGE 400° TO 650°C. S. F. Pugh (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 12: 355-7(1964).

Data on swelling in alpha uranium due to irradiation in the temperature range from 400 to 650°C were studied to determine degree of swelling as a function of burnup and temperature. (M.C.G.)

14102 SWELLING OF URANIUM BY MECHANICAL CAVITATION. C. L. Angerman and G. R. Caskey, Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Nucl. Mater., 13: 182-96(1964). (TID-20075)

Swelling of natural uranium was investigated in specimens irradiated to burnups of 0.05 to 0.77 at.% at temperatures in the range from 130 to 550°C. Cavities 10 to 200 μ in length were responsible for volume increases up to 50% in specimens irradiated to burnups of over 0.2 at.% at temperatures from 370 to 500°C. The cavities were absent at both lower and higher temperatures. These cavities were believed to form by shear along grain and twin boundaries in a manner similar to that responsible for the intergranular cavities or voids, which form during plastic deformation at temperatures just below the recrystallization temperature. In the case of the irradiated specimens, the necessary stress arises from interaction of crystallites resulting from anisotropic growth. The volume increase caused by precipitation of fission gas bubbles (0.01 to 0.5 μ dia) was only 0.5% for specimens irradiated at 370 to 500°C. Only 50% of the generated fission gas was accounted for by the gas bubbles in these irradiated specimens although all of the fission gas could be accounted for in specimens irradiated at 400°C and subsequently annealed at 580°C for 100 hours. (auth)

14103 THE EFFECT OF SELF-IRRADIATION ON THE LATTICE CONSTANTS OF ALLOYS OF PLUTONIUM IN ALPHA-URANIUM. A. F. Berndt (Argonne National Lab., Ill.). J. Nucl. Mater., 13: 263-4(1964).

The lattice constants of alloys of plutonium in alpha-uranium were measured after various periods of elapsed time to determine if these samples exhibit some effects due to lattice imperfections caused by self-irradiation. The quality of Debye-Scherrer patterns was not affected by storage of the samples. Alpha decay of the ^{239}Pu nuclei caused the ratio of uranium to plutonium in these samples to change. However, the resulting effect of this change on the lattice constants was negligible. Decay products caused the formation of numerous Frenkel defects. (M.C.G.)

14104 PRIMARY DAMAGE STATE IN FINITE NEUTRON IRRADIATED BeO SPECIMENS. J. R. Beeler, Jr. (General Electric Co., Cincinnati). J. Nucl. Mater., 15: 1-15(1965). (TM-63-11-6)

Machine calculations (IBM 7090) were made to estimate the influence of the neutron energy spectrum, incident neutron angular distribution, and specimen size and shape, on the primary damage state in finite, neutron-irradiated BeO specimens. Neutron spectra pertinent to test holes in the ETR and ORGR reactors as well as monoenergetic neutrons with energies in the range from 0.01 to 10 Mev were employed. Semi-finite, slab, and columnar specimen geometries were treated. The primary knock-on atom concentration, total defect concentration, and embryo vacancy cluster concentration produced by a unit, energy-integrated neutron flux were computed. The primary knock-on atom energy distribution and the embryo cluster size distribution were also obtained. Primary knock-on atom characteristics were obtained using a Monte Carlo method in which experimental angular distribution cross sections were used to describe anisotropic neutron scattering in the center of mass system as a function of neutron energy. The nature of the damage produced by primary knock-on atoms of a given type and energy was estimated by computing the entire collision cascade induced by this energetic atom in an exact representation of the wurtzite lattice structure of BeO. This deterministic calculation was used to study cluster production and to provide the four-element matrix of displacement functions required to compute the number of displaced atoms in a binary system. (auth)

14105 THE ANNEALING BEHAVIOUR OF THE RECIPROCAL LATTICE STREAKING IN NEUTRON IRRADIATED BERYLLIUM OXIDE. D. G. Walker (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Nucl. Mater., 15: 111-12 (1965).

In lattice photographs of neutron-irradiated BeO, streaking in the form of reciprocal lattice rods in the c* direction was observed. The annealing behavior of this streaking was studied and interpreted in terms of the damage structure of irradiated BeO. Lattice photographs were made of the "as-irradiated" crystal and after successive annealing for 1 hr at each of the following temperatures: 800, 1000, 1200, 1300, 1400, and 1500°C. Although there was little change for annealing temperatures below 1000°C, the streaking had almost disappeared by 1300°C and only a small residual effect was present at 1500°C. An estimate was made of the fraction of atoms contributing to the streaking was obtained. (M.C.G.)

14106 A NOTE ON PLASTIC EXPANSION OF IRRADIATED SPHERICAL SHELLS. Antoni Sawczuk (Illinois Inst. of Tech., Chicago). Nucl. Struct. Eng., 1: 155-8 (Feb. 1965).

Finite plastic expansion of a thick-walled spherical vessel was studied in presence of neutron radiation. Due to irradiation the yield stress and the hardening modulus varied across the shell wall. The pressure-expansion relation was obtained in case of combined linear hardening and linear attenuation. (auth)

14107 RADIATION EFFECT ON POLYETHYLENE. Munehiko Suzuki, Toshiya Kuroda, and Takeshi Kojima. Showa Densen Denran Rebyu, 13: No. 2, 50-5(Dec. 1963). (In Japanese)

Polyethylene samples from several commercial sources with varying density (0.911–0.959) were irradiated either in air or in nitrogen with a Toshiba Van de Graaff accelerator beta beam (2 Mev, 250 μA). The irradiated materials were subjected to various physical and chemical tests to determine changes in properties. Room temperature irradiation resulted in increased crosslinking with dose of low density material, however, there was also some oxidation, and net crosslinking effects were less than that resulting from irradiation in nitrogen or in vacuo. There was some improvement in dielectric property at high temperature, but no pronounced improvement of longer insulating life was observed. (TTT)

14108 EFFECT OF GAMMA RADIATION ON POLYESTER ENAMELED WIRE. Munehiko Suzuki, Takeshi Kawamata, and Etsuo Hosokawa. Showa Densen Denran Rebyu, 13: No. 2, 64-71(Dec. 1963). (In Japanese)

Samples of wire coated with polyester enamel were irradiated with cobalt-60 gamma rays (dose rate of 0.42 Mr/h, maximum dose up to 210 MR) to determine whether mechanical properties could be improved. The samples included polyester A (terephthalic acid polyester), polyester B (another terephthalic acid polyester), treated polyester A (polyester A with 10% phenol), treated polyester B (polyester A with 20% phenol), and treated polyester C (polyester A with 3% terephthalic acid). Polyester A was discolored most severely by radiation. Abrasion resistance of all samples was slightly reduced with increasing dose. No change was apparent in the number of times wire could be recoiled without visible signs of wear on enamel. Irradiated enamels containing phenol showed increasing resistance to wear when recoiled after heat treatment at 200°C for 12 hours. Very little difference in the useful life of irradiated and unirradiated materials was found when the materials were heated at prescribed temperature and duration, placed in a 75% relative humidity atmosphere at constant temperature for 12 hours, and impressed with 1000 v a-c for one second. Enamel made of polyester A showed slightly increased life. (TTT)

14109 EXCESS CONDUCTIVITY INDUCED IN GERMANIUM BY HYDROGEN ION BOMBARDMENT. I. A.

Abroyan, and L. A. Tsekhnovicher (Kalinin Polytechnical Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 1325-30(Dec. 1964). Translated from Fiz. Tverd. Tela, 6: 1688-95(June 1964).

The excess conductivity excited in germanium by atomic and molecular hydrogen ions with energies up to 7 kev is investigated. It is established that the experimentally observed changes of the electrical conductivity of germanium are due to the excitation of bound electrons of the semiconductor. A comparison of the data obtained on the effect of ion electron bombardment on the electrical conductivity of germanium shows that each hydrogen ion excites on the average three times more additional charge carriers than an electron with the same initial kinetic energy. (auth)

14110 EFFECTS OF COLD WORK AND NEUTRON IRRADIATION ON THE TENSILE PROPERTIES OF ZIRCALOY-2. Arden Lee Bement, Jr. Thesis, Ann Arbor, Mich., Univ. of Michigan. 1963. 194p.

Tensile tests of annealed and cold-rolled Zircaloy-2 both before irradiation and after fast neutron exposures at about 60°C to 10^{19}, 10^{20}, and 10^{21} neutrons/cm^2 (n/cm^2) were conducted. Specimens were taken both from the transverse and rolling directions of sheet containing 0, 10, 20, 40, and 70% cold work. The preferred orientations imparted by cold rolling were characterized by x-ray diffraction pole figures. The results show that anisotropy in the tensile properties of Zircaloy-2 with stress direction is due to the inhomogeneity of plastic deformation. Plastic deformation occurs both by slip and twinning, and the amount of twinning varies with stress direction in accordance with preferred orientation. Directional effects are also observed both in the plastic instability associated with necking and in fracture. The effects of preferred orientation on tensile properties are modified by neutron irradiation. Directionality effects on plastic instability are increased in annealed Zircaloy-2 by differences in radiation hardening mechanisms. Transverse specimens exhibit a yield point and neck at plastic strains less than 5% after exposures of 10^{19} n/cm^2. Changes in tensile properties saturate at about 10^{20} n/cm^2 exposure in longitudinal, cold-worked specimens. At higher exposures reversals in strength and ductility are observed. This apparent recovery occurs at temperatures below the thermal recovery ranges for both cold work and radiation damage and is attributed to interactions between dislocations and radiation-induced defects. (A.G.W.)

14111 A STUDY OF THE ELECTRICAL CONDUCTIVITY OF ALUMINA AT HIGH TEMPERATURES AND IN A RADIATION FIELD. William Bernard Haidler. Thesis, Tucson, Ariz., Univ. of Arizona, 1964. 103p.

Techniques and equipment were developed to permit measuring the electrical conductivity of a ceramic specimen at high temperature and in the radiation field of the University of Arizona's TRIGA reactor. The measurements were performed between ambient and 1800°K and at zero and 6 kw/liter of reactor power. The current through a polycrystalline alpha-alumina (Lucalox) sample was measured and the data were analyzed to yield the following conclusions: (1) the in-core electrical conductivity measurements are in reasonable agreement with previous out-of-core determinations; (2) irradiation of the specimen at 6 kw/liter causes a large increase in electrical conductivity at room temperature; however, as the specimen temperature is increased the relative effect of the radiation field decreases until at temperatures above 767°K it is insignificant in polycrystalline alpha-alumina; (3) the increased electrical conductivity is caused by the reactor gamma emissions interacting within the specimen to cause an increased number of electronic charge carriers; (4) there is no indication of polycrystalline alpha-alumina becoming an intrinsic semiconductor in the temperature range 300–1600°K; (5) electronic conduction possibly accounts for conductivity below 1000°K above which extrinsic ionic conduction takes place; the activation energies of the processes were determined to be 0.47 ev and 1.9 respectively. Because of systematic errors less importance is assigned to the absolute values of electrical conductivity obtained than to the relative change with irradiation. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14112 LOW ENERGY PROTON DAMAGE EFFECTS IN SILICON AND GALLIUM ARSENIDE SOLAR CELLS. D. M. Brown (Goddard Space Flight Center, Greenbelt, Md.). 21p. (CONF-617-15)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

Silicon N/P cells of various base resistivities and gallium arsenide P/N solar cells were irradiated with nominally 0.6, 1.8, and 4.7 Mev protons. In the first experiment silicon N/P cells of various base resistivities and gallium arsenide cells were irradiated with 4.7 Mev proton, measuring Isc and V open as functions of flux. In the second experiment, the same types of cells were irradiated with 0.6 Mev protons, with I-V curves and spectral responses being measured. In the third experiment, a similar set of cells were irradiated with 1.8 Mev protons, with I-V curve and spectral response being measured. (auth)

14113 THE EFFECTS OF STEADY-STATE NUCLEAR RADIATION ON PERMALLOY MAGNETIC FILMS. W. D. Miller and D. I. Norman (UNIVAC, St. Paul). 34p. (CONF-617-12)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

The effects of nuclear radiation on thin magnetic films were studied experimentally in a steady-state nuclear radiation environment. The extent of radiation effects in the films was characterized in terms of measured deviations of magnetic parameters observed for exposures to various flux levels. The nature and extent of damage to the films is discussed as a function of mixed neutron-gamma integrated fluxes and radiation-induced heating of the films. The influence of protective coatinga applied to the films to prevent damage from non-nuclear environmental conditions is observed and evaluated. The relative importance of radiation heating of the substrate is compared to the effect of radiation-produced displacements and disorder in the material of the films as a damage mechanism. The threshold for significant permanent damage from a mixed neutron-gamma environment is discussed qualitatively. (auth)

METEOROLOGY

Refer also to abstracts 13631, 13645, and 13859.

14114 (DASA-1305) PROJECT STAR DUST. Fifth Quarterly Report. James P. Friend and Herbert W. Feely (Isotopes, Inc., Westwood, N. J.). Aug. 1, 1962. Contract DA-49-146-XZ-079. 90p. (AD-424042). $8.60(OTS).

Two preliminary versions of the Star Dust model of atmospheric mixing and transfer have been run on a computer and have been checked against HASP tungsten-185 data. The results obtained have tended to substantiate the validity of the basic design of the model and have indicated some modifications which are needed in it. Most results are now available from radiochemical analysis of Star Dust samples collected during early 1962. These include preliminary measurements of several products of neutron activation in the debris from 1961 Soviet tests. The total burden of strontium-90 in the stratosphere of the Northern Hemisphere during January–April 1962 was approximately 1.6 or 1.7 megacuries, about 1.3 or 1.4 megacuries of which had been produced by the 1961 Soviet tests. The total burden of strontium-90 in the entire stratosphere was probably about 2 megacuries at that time. There is evidence that the layer of air in the northern polar stratosphere which contained the highest concentrations of strontium-90 from pre-1961 tests had subsided during the winter of 1961–1962 from an altitude of 70,000 feet or higher in mid-1961 to about 60,000 feet by early 1962. The highest concentrations of debris from the 1961 Soviet tests continued to be found at 50,000 feet in the northern polar stratosphere throughout early 1962, but vertical mixing gradually increased the low concentrations of debris at 65,000 and 70,000 feet. The influx of antimony-124 into this highest sampled layer during early 1962 indicates that debris from above 70,000 feet must have contributed, in part at least, to this increase. Less than 10 percent of the debris from the 1961 Soviet tests had mixed into the tropical stratosphere by May 1962. The mean altitude of stabilization of debris from the 1961 Soviet tests was probably at least 10,000 feet above that of debris from the October 1958 Soviet tests. As a result the debris from the 1961 tests will exhibit a longer stratospheric residence time, with perhaps half of it being detained in the stratosphere for more than a year before falling out. Changes which occurred in concentrations of debris near the tropopause during early 1962 suggest that both the rising of the polar tropopause during the spring months and horizontal mixing through the tropopause gap region (or through the sloping polar tropopause) are important in contributing to the increase in fallout rate at the surface of the earth during the spring season. (auth)

14115 (NYO-2363-2) STRATOSPHERIC MONITORING PROGRAM. Semi-Annual Progress Report, March–August 1964. M. Lippmann and L. R. Solon, comps. (Del Electronics Corp., Mount Vernon, N. Y.). Dec. 10, 1964. Contract AT(30-1)-2363. 43p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Progress is reported in all phases of the stratospheric aerosol sampling program. An electrostatic precipitator comprising a 37-tube corona-discharge array was designed and preliminary construction and assembly of a unit for atmospheric sampling up to 150,000 ft altitude was undertaken. An electrical discharge altimeter was built for operation at 75,000 to 180,000 ft. Its measurement reproducibility, under the same conditions of temperature and pressure, is within 0.1%, while its accuracy is dictated by naturally occurring departures from the standard altitude-pressure curve. In general, with pressure or temperature departures of ±20% from the 1962 Standard Atmosphere, altitudes at 10^5 ft can be measured with an accuracy of better than ±5%. A flowmeter based on ion tracer principles was designed and a breadboard prototype of an operational system was assembled. The flowmeter is capable of measuring flowrates at altitudes of 10^5 ft to 1.5×10^5 ft with an accuracy of ±5%. Preliminary telemetry and recording principles were developed for the next series of flights employing electrostatic precipitators and sample recovery techniques were worked out for 37-tube sampling configurations. (auth)

14116 (JPRS-28343) PROBLEMS OF ATMOSPHERIC DIFFUSION AND AIR POLLUTION. Translated from Tr. Gl. Geofiz. Observ., No. 158, 3-40; 46-101; 101-19; 123-35(1964). 166p. (TT-65-30148). $5.00(OTS).

Fifteen articles are presented on the following subjects: pollution by power plants, diffusion in stratification conditions, turbulent exchange, smoke propagation from stacks, fallout, radiometers, sounding radiation meters, radioactivity of air and dust, etc. (D.L.C.)

14117 WASTE GAS DIFFUSION EXPERIMENT USING SILVER IODIDE SMOKE. K. Ito. Genshiryoku Kogyo, 9: No. 2, 33-5(1963). (In Japanese)

Determination of the atmospheric distribution of radioactive waste gas by a smoke of silver iodide particles is described. Silver iodide particles were generated by burning a 5% acetone solution of silver iodide in a generator at 600 to 900°C. The particle smoke thus produced was sent up into the air through a 5-m-long chimney. An ice box and air contamination meter of the paper filter type were used for collection of silver iodide particle smoke and detection of ice crystals. Smoke samples were collected in a 1-liter metal cylinder (ice box) which was cooled by dry ice to −17.5°C. Fine crystals formed in the ice box with the iodide particles as the nuclei fell into a supercooled saturated sugar solution at the bottom of the cylinder, and the total number of ice crystals growing to a size visible by naked eye in a short time, was counted. A paper filter type air contamination meter was used for counting. The sample was made to pass at certain rate through a paper filter for a certain length of time and the subsequent collection of the ice crystals on the paper filter was counted as above. Another method was also used, which involved exposing a piece of filter paper in the air for the adsorption of particles to take place. The smoke generator was operated at 860°C and the concentration of particles was 5×10^6/cc while the height at the smoke source was 20 m and the direction and speed of the wind was 7.0 m/sec. While the number of smoke particles in the air recorded by the ice-box method was merely a transient value, the paper filter method recorded the total number throughout the period of sampling. The results revealed that, in addition to the influence of wind speed and direction and temperature, the diffusion of silver iodide particles was considerably affected by the terrain and roughness (houses and trees etc.) of the ground surface. (auth)

14118 METEOROLOGICAL CONSIDERATIONS ON THE DIFFUSION OF ARGON-41 AT ISPRA. Pietro Gaglione, Claudio Gandino, and Alessandro Malvicini (C.C.R.-EURATOM, Ispra, Italy). Ing. Nucl., 5: No. 5, 3-8(Sept.-Oct. 1964). (In Italian)

The method, employed in the radiological monitoring network at the Joint Nuclear Research Center at Ispra, for the determination of the gamma dose rate from ^{41}Ar is described. The results obtained during 1963 are correlated with the meteorological diurnal cycle with emphasis on the morning fog. (auth)

14119 ON THE STUDY OF THE FORMATION OF HAILSTONES BY MEANS OF ISOTOPIC ANALYSIS. I. H. Bailey and W. C. Macklin (Univ. of Western Australia, Nedlands). J. Geophys. Res., 70: 493-7(Jan. 15, 1965).

A previously described method for studying the structure of hailstones by measuring the D/H ratios in the layers of ice constituting a stone is discussed. It is shown that this method permits one to make quantitative predictions concerning the updraft required to support the stone, and these predictions are used to investigate the validity of the technique. (C.E.S.)

14120 CHEMICAL COMPOSITION OF UPPER ATMOSPHERE. Sugiura Esno. Kagaku (Kyoto), 18: No. 1, 20-5 (1963). (In Japanese)

The CO_2 content of the upper atmosphere was measured. Water vapor in the atmosphere decreases with increasing height, reaching a minimum at the lower limit of the stratosphere but then increasing slightly to a constant value. Ozone increases with height to a maximum at 25 km, its upper limit being at 50 km. At the upper limit of the mesosphere, water is decomposed by light to OH and H. At 100 km, CO_2 forms NO and NO_2 by photochemical reaction with N, O, O_2, etc. In the exosphere the light gases H_2, He, and others diffuse into the cosmic space. The Na layer is 70-100 km high. Nuclear reactions caused by cosmic rays produce ^{3}H, ^{7}Be, ^{10}Be, ^{14}C, ^{22}Na, ^{32}Si, ^{32}P, ^{33}P, ^{35}S, ^{36}Cl, and other nuclides, found chiefly in rain water. These nuclides increase with height and latitude. Near the equator and 40°N latitude, ^{90}Sr is high because of nuclear explosions. Particle sizes also differ with height and latitude. (TCO)

PHYSICS

General

14121 (AD-608278) PARAMAGNETIC RELAXATION OF SOME RARE-EARTH IONS IN DIAMAGNETIC CRYSTALS. Technical Report No. 452. Chao-Yuan Huang (Harvard Univ., Cambridge, Mass. Cruft Lab.). Aug. 4, 1964. Contract Nonr-1866(16). 158p. $5.00(OTS).

The pulsed saturation method at 8.9 kMc/sec was used to measure the spin-lattice relaxation rate T_1^{-1} for Eu^{2+}, Ho^{3+}, and Tm^{2+} in CaF_2, for Yb^{3+} in YGG, YA1G, and LGG, for Nd^{3+} in YGG and YA1G, and for Sm^{3+} in lanthanum ethyl sulfate at low temperatures. Besides the expected direct, Orbach, and Raman processes, a process, $T_1^{-1} \propto T^5$, was observed for Eu^{2+} in CaF_2 in the temperature region $15°K < T < 30°K$. A pronounced anisotropy in T_1 (a factor ~6) for Sm^{3+} in LES was also observed. The experimental data are in satisfactory agreement with the theoretical predictions based on the combined Van Vleck-Orbach theory. For example, for 0.02% Ho^{2+} in CaF_2, the data show $1/T_1 = 42\ T + 8.0 \times 10^9 \exp(-33.1 \cdot 1.44/T)\ sec^{-1}$, as compared to the theoretical prediction, $1/T_1 = 37\ T + 8.5 \times 10^9 \exp(-33.4 \cdot 1.44/T)\ sec^{-1}$. The data, combined with those of others, lead to an empirical formula for rare earth ions except Eu^{3+} and Gd^{3+}, $1/T_1 \sim 10^{46} \Sigma_{p_t} (g^2\beta^2H^4T/\rho v^5\Delta_{p_t}^2)|\langle p_t|J_z|a\rangle|^2 + 10^{-9} \Sigma_{p_t}(T^9/\rho^3 v^{10}\Delta_{p_t}^4) + 10^{82} \Sigma_{p_t}(\Delta p_t^2/\rho v^5) \exp(-\Delta_{p_t}/kT)\ sec^{-1}$, which is successfully applied for the cases Nd^{3+} in YGG and YA1G. The relaxation data of Eu^{2+} have been found to be $1/T_1 = 12\ T + 5.3 \times 10^{-4}\ T^5\ sec^{-1}$. It is in very good agreement with the theoretical estimate $1/T_1 \sim 3\ T + 4 \times 10^{-4}\ T^5\ sec^{-1}$. It is, therefore, concluded that the spin-lattice relaxation of rare earth ions at low temperatures is well understood. A new theory about the spin-optical phonon relaxation is proposed. The theory gives a new temperature dependence that $T_1 \propto \exp(\kappa\omega_0/kT)$, where $\kappa\omega_0$ is the optical phonon energy at k = 0. (auth)

14122 (ARL-64-178) ON COOLED ANODES IN CONTACT WITH LAMINAR ARC-HEATED FLOWS. Harris B. McKee, Robert C. Dean, Jr., and Agnar Pytte (Dartmouth Coll., Hanover, N. H.). Oct. 1964. Contract AF33(657)-8179. 81p. (AD-609910). $3.00(OTS).

This paper is concerned with the physics and operating characteristics of cooled anodes in contact with an arc-heated laminar plasma flow in a constant area duct. Various modes of anode behavior are identified and described. Some influences of gas type, flow rate, arc current, anode material and geometry are demonstrated. A theory is developed to explain the low-current mode of the anode characteristics. It is shown that the local current density on the anode surface is related approximately to the surface's local bias relative to its electrically floating voltage. Anode current distribution data are presented; the distribution is shown to be unstable above a transition bias voltage, with the current concentrating intensely on the edge of the anode toward the cathode. Neighboring points on the duct wall are shown to be electrically independent. This fact greatly simplifies an interpretation of anode phenomena. The information presented makes a fairly complete picture of the physical behavior of finite-length, cooled anodes in contact with fully-developed laminar plasma-arc flows. (auth)

14123 (ARL-64-192) AN UNCOOLED, RAPID RESPONSE PROBE FOR MEASURING STAGNATION PRESSURES IN HIGH VELOCITY ARC PLASMA. P. Barkan and A. M. Whitman (General Electric Co. Power Transmission Div., Philadelphia). Nov. 1964. Contract AF33(657)-8206S1. 55p. (AD-609621). $3.00(OTS).

A means is described for measuring stagnation pressures in high-temperature, high-current plasmas. The device employs a small (<0.060 in. o.d.) uncooled pitot tube designed for minimum response time (<0.001 sec), which is rapidly swept through the plasma flow field (<0.015 sec). A simple technique for evaluating the transient response of the probe is described. Because the probe tip is inexpensive and expendable, a moderate amount of molten phase ablation is tolerable in the stagnation zone. Consequently, it appears possible to obtain meaningful results at heat flux rates exceeding 10^4 cal/cm²-sec. In preliminary tests a single probe was successfully employed for eight successive measurements of total pressure in an atmospheric pressure, air-arc plasma at currents ranging from 200 to 1000 amperes at Mach numbers close to unity. Heat flux rates encountered are estimated to be in the vicinity of 2000 to 3000 cal/cm²/sec. The merits of the probe described include its small size, its rapid response, and its inexpensive, expendable probe tip. (auth)

14124 (ARL-64-210) ELECTRON-HEAVY-PARTICLE NONEQUILIBRIUM IN AN ARGON ARCJET. Martin P. Sherman, Paul F. Jacobs, and Jerry Grey (Princeton Univ., N. J.). Aug. 1964. Contract AF33(657)-9962. 37p. OTS.

The departure from equilibrium in a dense, partly-ionized arcjet exhaust is estimated in terms of the mole fractions of the various constituents, the electron-heavy particle temperature difference, and the populations of excited states. Cooling of the arcjet is accomplished by mixing with a different cool gas; the example studied is that of a hot subsonic argon jet mixing with cool helium at one atmosphere, using measured time rates of temperature decay. The energy-exchange processes considered are elastic collisions, radiation, and various types of ion-electron recombination. It is concluded that the electron-heavy particle temperature difference is small when the temperature decay rate is small (i.e., slow mixing), but can be of the order of 20% of the heavy-particle temperature at the highest temperature decay rates observed experimentally. In the latter case, therefore, it cannot be assumed that the arcjet exhaust is in equilibrium, and further experimental data are needed to establish the quantitative nature of the departure from full thermodynamic equilibrium. (auth)

14125 (BNL-8663) COMPUTATIONAL RESULTS FOR THE HEM_{11} MODE IN IRIS-LOADED DEFLECTORS. H. Hahn (Brookhaven National Lab., Upton, N. Y.). Nov. 18, 1964. Contract [AT(30-2)-Gen-16]. 11p. Dep. (mn); $1.00(cy), 1(mn) OTS.

Numerical results of computations performed on the IBM 7090/94 for the properties of the HEM_{11} deflecting mode in circular waveguides are compiled. (T.F.H.)

14126 (FSU-2690-14) ELECTRON IMPACT STUDIES ON SIMPLE GASEOUS MOLECULES. Bulletin No. 14. (Florida State Univ., Tallahassee and Florida State Univ., Tallahassee. Inst. of Molecular Biophysics). May 1, 1964. Contract [AT(40-1)-2690]. 55p. Dep.(mn); $3.00 (cy), 1(mn) OTS.

Two papers are presented on cross sections for dissociative ionization of several gases and ionization of nitrogen near threshold, respectively. Separate abstracts were prepared for both papers. (D.L.C.)

For abstracts of individual papers see: 14127 and 14128.

14127 (FSU-2690-14(Paper 1)) IONIZATION CROSS SECTIONS FOR DISSOCIATIVE ELECTRON-MOLECULE COLLISIONS. R. E. Glick and J. A. Llewellyn (Florida State Univ., Tallahassee and Florida State Univ., Tallahassee. Inst. of Molecular Biophysics). 13p.

Ionization cross sections for fragment ion production were measured using a pulsed ion collecting field and time-of-flight mass analysis. The results for N_2, O_2, NO, and CH_4 when summed over all fragments are in good agreement with the total ionization measurements of other workers. (auth)

14128 (FSU-2690-14(Paper 2)) A STUDY OF THRESHOLD BEHAVIOR OF ELECTRON IMPACT INDUCED IONIZATION AND DISSOCIATIVE IONIZATION OF NITROGEN. J. A. Llewellyn and R. E. Glick (Florida

State Univ., Tallahassee and Florida State Univ., Tallahassee. Inst. of Molecular Biophysics). 40p.

The behavior of nitrogen under ionizing electron impact was studied using a mass spectrometer to determine absolute values for ionization and dissociative ionization cross sections. R.P.D. methods were used together with efficient ion collecting techniques and, as observed previously, linear segments were obtained in cross section versus energy plots. The cross-section values obtained are tabulated. The conditions under which linear behavior is anticipated are analyzed in terms of known relative Franck-Condon factors and the contributions of autoionization and predissociation to this behavior are also assessed. A mechanism for the dissociative ionization at threshold is discussed. (auth)

14129 (IA-994) MICROSCOPIC THEORY OF IONIC DIELECTRICS. R. Englman (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Dec. 1964. 71p.

A careful treatment of the Schroedinger equation, including the electron-phonon interaction, for ionic solids leads to the clarification of existing concepts and to the derivation of new results. The work covers the thermodynamic properties, the ordinary dielectric behavior, and the ferroelectric phase of ionic dielectrics. (auth)

14130 (IS-1024) ANGULAR CORRELATION OF ANNIHILATION GAMMA RAYS AND CRYSTAL ORIENTATION. Roger Lee Bredeweg and D. J. Zaffarano (Ames Lab., Ames, Iowa). Nov. 1964. Contract W-7405-eng-82). 47p. Dep.; $2.00(cy), 2(mn) CFSTI.

A correlation between the direction in which the annihilation gamma rays are emitted and the shape of the Fermi surface is investigated in single crystals of beryllium, lead, tin, and sodium tungsten bronze. A fast-slow coincidence is used. The results do not indicate a correlation between the shape of the Fermi surface and the direction of the emitted gamma rays. (auth)

14131 (LAMS-3002(Suppl.I)) STATUS REPORT ON OPACITY CALCULATIONS. SUPPLEMENT I. Walter F. Huebner and Robert S. Stuart (Los Alamos Scientific Lab., N. Mex.). Oct. 9, 1964. Contract W-7405-eng-36. 74p. Dep.; $3.00(OTS).

The results of a survey in the opacity field were compiled and are presented categorized according to the various phases of an opacity calculation. The categories considered include: energy levels, wave functions, electronic occupation, bound-free transitions, free-free transitions, bound-bound transitions, scattering, molecular transitions, and complete opacity calculations. A list of scientists recently active in one or more of these fields is included. (auth)

14132 (LGI-63/18) MAFIN II — EVALUATION DU MAXIMUM DE COMPRESSION. (MAFIN II — Evaluation of The Maximum of Compression). J. P. Somon (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Sept. 1963. 63p. Dep.(mn).

The decomposition of the movement in the incompressible linear model makes possible the systematic numerical calculation, as a function of the four parameters Λ_1, Λ_2, ρ_1, and b_0, of the values of the physical magnitudes significant at the moment of maximum compression. Curves relative to these magnitudes are traces in the plane (Λ_1, Λ_2). The rate of maximum compression thus obtained is not very different from the rate calculated in a shock-wave model. (tr-auth)

14133 (NP-14769) SHOCK STRUCTURE IN A PARTIALLY IONIZED GAS. Fluid Mechanics Laboratory Publication No. 64-9. Michel Y. Jaffrin (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). Oct. 1964. Contract Nonr-1841(93). 80p.

The one-dimensional, steady state structure of a shock wave in a partially ionized gas is investigated using the Navier-Stokes equations for the atom, electron, and ion fluids. The plasma is assumed quasi-neutral without a change in ionization across the shock. A characteristic feature common to weakly and strongly ionized gases is the existence of a broad layer of elevated electron temperature (thermal layer) ahead of the shock front due to the high electron thermal conductivity and of a precursor and an imbedded axial electric field induced by the charge separation. Because of the large atom-ion collision cross section due to the charge exchange mechanism, the ion slip is small when less than 30% of the plasma is ionized. In a weakly ionized plasma, the atom flow is unaffected by the ionized particles and the structure consists of an ordinary atom shock imbedded in the thermal layer. When the plasma is substantially ionized, the heavy particles are partially compressed and heated in the thermal layer and the ion and atom temperatures overshoot their downstream values in the shock. The induced electric fields increase with the degree of ionization and the free stream Mach number while the shock thickness decreases. An experimental measurement in partially ionized hydrogen of the variation of potential in a strong shock gives a shock thickness and a potential rise across the imbedded shock in good agreement with the calculated values. (auth)

14134 (NP-14784) APPLICATION OF VARIATIONAL METHODS FOR THE SOLUTION OF GASDYNAMIC AND MAGNETOGASDYNAMIC PROBLEMS. Scientific Report No. 8. F. Cap and G. Mueller (Innsbruck. Universität. Institut für Theoretische Physik). Feb. 25, 1964. Contract 61(052)-675. 10p.

A variational principle that can be solved in the gas dynamic and magnetogasdynamic subsonic domain, the transonic domain, and the supersonic domain by means of the Ritz method is obtained for compressible flow past a cylinder. (C.E.S.)

14135 (NP-14785) INTERPRETATION OF MAGNETOGASDYNAMIC FLOW PATTERNS. Scientific Report No. 10. F. Cap and H. Friedel (Innsbruck. Universität. Institut für Theoretische Physik). Apr. 25, 1964. Contract 61(052-675). 18p.

For initial magnetic fields of 0, 1000, 5000, and 10000 gauss the two-dimensional steady flow of a plasma in a nozzle is constructed using the MGD characteristics method. (auth)

14136 (NP-14786) MAGNETOGASDYNAMIC WAVES OF SMALL AMPLITUDE. Scientific Report No. 12. F. Cap and H. Friedel (Innsbruck. Universität. Institut für Theoretische Physik). July 14, 1964. Contract 61(052)-675. 14p.

The propagation of MGD waves with small amplitude is studied with two methods. In the first part the calculations are based on the linearized MGD equations, and in the second part consistent results are obtained applying the theory of characteristics. (auth)

14137 (NP-14788) VORTEX THEOREMS AND POTENTIAL FLOW IN MGD. Scientific Report No. 14. F. Cap and H. Friedel (Innsbruck. Universität. Institut für Theoretische Physik). Sept. 25, 1965. Contract 61(052)-675. 10p.

Necessary conditions for the existence of a velocity-potential in MGD are derived on the basis of general MGD vortex theorems. Two types of MGD flows, fulfilling these conditions, are given. The existence of a potential-equation for the special case of a longitudinal magnetic field is shown. (auth)

14138 (NP-14789) SOME PRACTICAL EXAMPLES OF ONE-DIMENSIONAL UNSTEADY POTENTIAL FLOWS IN MGD. Scientific Report No. 11. Ferdinand Cap and Franz Herrnegger (Innsbruck. Universität. Institut für Theoretische Physik). June 14, 1964. Contract 61(052)-675. 19p.

For initial magnetic fields of 5000 and 50,000 gauss the one-dimensional unsteady flow of a plasma in a tube is constructed using the MGD characteristics method. (auth)

14139 (NP-14790) VARIATIONAL METHODS FOR THE SOLUTION OF TWO-DIMENSIONAL STEADY MAGNETOGASDYNAMIC FLOWS. Scientific Report No. 19. F. Cap and G. Mueller (Innsbruck. Universität. Institut für Theoretische Physik). Sept. 23, 1964. Contract 61(052)-675. 12p.

The variational problem describing two-dimensional steady magnetogasdynamic potential flow was transformed and a method to solve it was outlined. (auth)

14140 (NYO-1480-8) ACCURACY AND LIMITS OF APPLICABILITY OF SOLUTIONS OF EQUATIONS OF TRANSPORT; DILUTE MONATOMIC GASES. Harold Grad (New York Univ., New York. Courant Inst. of Mathematical Sciences). Sept. 30, 1964. Contract AT(30-1)-1480. 25p. (MF-42; CONF-640102-1). Dep.(mn); $1.00 (cy), 1(mn) OTS.

From International Seminar on the Transport Properties of Gases Meeting, Providence.

The theory of the Boltzmann equation for a simple gas of monatomic molecules is surveyed. Various formulations of this equation are considered, as regards their accessibility to theory. The linear theory, the Knudsen number, and the approach to fluid dynamics are considered. (T.F.H.)

14141 (RLE-TR-424) TRAVELING DENSITY VARIATIONS IN PARTIALLY IONIZED GASES (thesis). Robert Shanklin Cooper (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Feb. 10, 1964. Contract DA 36-039-AMC-03200(E).

The problem of the propagation of macroscopic waves of ionization within the positive column of glow discharge tubes is investigated. In the literature of this field these waves have been called moving striations because of the visible radiation emanating from the traveling pulse. Both experimental and theoretical analyses of this phenomenon were made. The principal experimental result is the establishment of a linear regime of operation for the observed traveling waves and the artificial excitation of them. The principal theoretical result is the derivation and the analysis of a linear theory that is applicable to the experimental regime of operation. (auth)

14142 (TID-3911(Rev.2)) THERMOLUMINESCENCE. Bibliography. Ernest E. Angino (Texas. Agricultural and Mechanical Univ., College Station), N. Grogler (Bern. Universität. Physikalisches Institut), and Richard McCall (Controls for Radiation, Inc., Cambridge, Mass.). [nd]. 108p. Dep.; $4.00(OTS).

Approximately 1250 references are presented which are arranged alphabetically by author. (D.L.C.)

14143 (UCRL-7907(Rev.I)) CORRESPONDING STATES AT SMALL INTERATOMIC DISTANCES. R. Norris Keeler, Berni J. Alder, and Mathias van Thiel (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 1964. Contract W-7405-eng-48. 7p. Dep.; $1.00(cy), 1(mn) CFSTI.

It is found that Ar and Xe exist in corresponding states in single shock waves at pressures below 200 katm. Above this pressure, strong deviations from corresponding-state behavior appear, which are attributed to large-scale thermal excitation of electrons in Xe to the conduction band across a pressure-narrowed energy gap. (T.F.H.)

14144 (WL-TDR-64-89) EXPERIMENTAL STUDIES ON HEAVY ION EXCHANGE IN AIR. Final Report. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 1964. Contract AF20(601)-6106. 54p. (AD-608271). $3.00(OTS).

Charge-changing collisions between Al^+ ions and the gases Ar, N_2, O_2, and air have been examined over the velocity range 0.25 to 1.9×10^8 cm sec^{-1}. Fast particle detection was used to obtain values for the electron capture cross section σ_{10}, and the ion stripping cross section σ_{11} and σ_{13}. Higher ion stripping cross sections and capture cross sections to form negative ions of Al were negligible in comparison. In the lower velocity range (0.25 to 0.8×10^8 cm sec^{-1}), measurements of the total apparent ionization cross section of the target gas were made using slow particle detection. Estimates of the neutral Al stripping were made at the higher velocities, and these were found to be almost an order of magnitude higher than σ_{10}. Ion sources for Al^+ and other metallic ions are discussed together with general considerations pertaining to experiments using such ions. (auth)

14145 (CEA-tr-R-1799) FOCALISATION D'UN FAISCEAU DE PARTICULES CHARGEES. (Focusing of Charged Particle Beams). Kelman. Translated by B. de Trezvinsky into French from Chap. III, p.66-88 of "Optique Electronique." [nd]. 58p. Dep.(mn); $5.60(fs), $1.94(mf) JCL.

The general Grinberg theory on the focusing action of continuous electric and magnetic fields is outlined, and the equations expressing focusing in an electric field are given. Some individual cases of charged-particle focusing are discussed. (J.S.R.)

14146 (FTD-TT-64-803) ON THE EFFECT OF A TRANSVERSE MAGNETIC FIELD ON RESISTANCE OF PLATE. A. Tsinober and E. Shcherbinin. Translated from Latvijas PSR Zinatnu Akad. Vestis, No. 6, 43-8(1963). 9p. OTS.

An experimental investigation of the effect of a transverse magnetic field on the resistance of a plate around which is directed a laminar flow of an electric conducting fluid was conducted. An approximate calculation of the boundary layer on a plate in the presence of a magnetic field is also included. (C.E.S.)

14147 (SC-T-65-705) EQUIVALENT CIRCUIT FOR INTERNAL DISCHARGES IN A SOLID DIELECTRIC. A. Ververka and A. Hon. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Acta Tech. CSAV, 8: 509-23(1963). 12p. Dep.(mn); $1.60(fs), $0.80 (mf) JCL.

To get the history of discharges in a gap of a dielectric, we supplement the equivalent capacitance circuit of the inner discharges with resistances, which represent the respective surface resistance in the gap and in the dielectric. It is shown that the supplemented circuit is sufficient for explanation of experimental observations of the investigated arrangement. (auth)

14148 (UCRL-Trans-1175) TRANSVERSE STABILITY OF A CHARGED PARTICLE BEAM IN A CHAMBER WITH CIRCULAR CROSS SECTION. V. I. Balbekov and A. A. Kolomenskii. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Berkeley), from Russian Preprint, 1964. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

A dispersion equation is derived and studied for the transverse oscillations of a thin beam of charged particles moving in a circular tube with non-ideally conducting walls. Conditions are examined at which instability of the beam can appear and methods are pointed out for its suppression. (auth)

14149 ON A PROBLEM OF ELECTRODYNAMICS. K. I. Kim. Dopovidi Akad. Nauk Ukr. RSR, No. 10, 1326-30 (1964). (In Ukrainian)

The construction of the lateral walls of a channel from a conducting material is an effective means for limiting Hall effects in a liquid moving in a traveling magnetic field. The algorithm for computation of stationary electromagnetic processes in a liquid is indicated for the given case. (auth)

14150 THEORY AND APPLICATIONS OF ELECTRON BOMBARDMENT. J. Van Audenhove (EURATOM, Geel, Belg.). Ingenieursblad, 33: No. 7, 3-19(1964). (EUR-1204.n) (In Dutch)

A survey is given of the main factors which control the emission of electrons and their concentration into beams. Various kinds of electron guns, as well as the electric, mechanical, and vacuum devices used in them, are described. It is shown that electron bombardment technology has many applications. (auth)

14151 PRODUCTION OF CONSTANT AXIALLY-SYMMETRICAL MAGNETIC FIELD IN A FERROMAGNETIC SYSTEM. G. V. Badalyan (Erevan Physics Inst.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk, 17: No. 5, 121-6(1964). (In Russian)

The magnetic field produced inside a closed cylindrical ferromagnetic shell by a coil having a specified distribution of ampere turns and wound coaxial with the shell is calculated. The inverse problem is also solved, that of producing a specified axially symmetrical magnetic field with the aid of a suitable distribution of the ampere turns. The purpose of the investigation was to obtain improved

magnetic lenses for electron-optical devices. The calculations are conventional and involve the solution of the Laplace equation with proper boundary conditions. The solution of the problem for a magnetic lens with open (not iron) ends calls for a separate analysis. (ATD)

14152 MOTION OF RELATIVISTIC ELECTRON WITH ORIENTED SPIN IN A CONSTANT AND HOMOGENEOUS MAGNETIC FIELD. A. A. Sokolov, I. M. Ternov, and V. G. Bagarov (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 41-50(1964). (In Russian)

Some results of a study of the motion of polarized electrons in a magnetic field are presented. A relativistic-covariant description of the spin properties of an electron in an external magnetic field is given. Expressions are obtained for the electron-beam polarization with synchrotron radiation. The effects of vacuum magnetic moment and of scattering by the short-range force on electron-spin orientation are considered. (M.J.T.)

14153 MOTION OF POLARIZED ELECTRON WITH A VACUUM MAGNETIC MOMENT. I. M. Ternov, V. G. Bagrov, R. A. Rzaev, and Yu. I. Klimenko. Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 111-21(1964). (In Russian)

The motion of an electron with oriented spin in a constant homogeneous magnetic field is considered. The effect of the vacuum magnetic moment of the electron on the longitudinal and transverse spin orientation is analyzed. The exact solutions of the Dirac equation taking the vacuum moment into consideration are applied to the calculation of the probability of change of electron-spin orientation during irradiation. (tr-auth)

14154 WEINREICH RELATION IN THE PRESENCE OF dc ELECTRIC AND MAGNETIC FIELDS. Harold N. Spector (Case Inst. of Tech., Cleveland). J. Appl. Phys., 34: 3628(Dec. 1963).

It is shown that the Weinreich relation between the absorption coefficient of sound and the acoustoelectric force on electrons is generally valid in both d-c electric and magnetic fields, as long as the sound wave is interacting with only one kind of charged carrier (i.e., either electrons or holes, but not both). Corrections on the absorption coefficient and the acoustoelectric force are derived for the case when the collision drag effect is important. (M.J.T.)

14155 ACOUSTOELECTRIC EFFECT. S. G. Eckstein (Argonne National Lab., Ill.). J. Appl. Phys., 35: 2702-7 (Sept. 1964).

General expressions for the acoustoelectric current in the presence of external electric and magnetic fields were derived. The Weinreich relation is shown to be valid in materials in which carriers of one sign only are present, to the extent that collision-drag effects may be neglected. The Weinreich relation is not valid for semimetals. However, in high magnetic fields, the acoustoelectric current and field in semimetals are proportional to the attenuation. The acoustoelectric field is then in the direction $q \times H$, where q is the wave vector and H the magnetic field. The acoustoelectric current reinforces the original direct current under amplifying conditions, in agreement with observations of anomalous magnetoresistance in Bi. (auth)

14156 EFFECTS OF FINITE SAMPLE SIZE ON THE MEASUREMENT OF TRANSPORT QUANTITIES. Ralph Nossal (Universite Libre, Brussels). J. Math. Phys. (N. Y.), 6: 193-200(Feb. 1965).

A determination is made of the temporal evolution of the momentum autocorrelation function for a noninteracting gas constrained by walls. A frequency-dependent dielectric constant is calculated from the latter by applying an appropriate Kubo relation. Deviations from the Drude conductivity are obtained which, for high frequency and/or large systems, are found to be $\sim o(10^2/\beta m\omega^2 L^2)$, where L is the spatial dimension of the assembly and ω the frequency of the applied field. A similar calculation is performed to determine the effects of boundaries upon measurements of scattering cross sections for slow neutrons. It is found that, for realistic experimental conditions, wall perturbations are unlikely to be of importance. (auth)

14157 CORRELATION FUNCTIONALS. D. Ruelle (Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.), 6: 201-20(Feb. 1965).

The correlations between positions of particles in classical equilibrium statistical mechanics are usually expressed by correlation functions. It can be seen that if the correlation functions of a system are known, its configurational entropy per unit volume is already determined (independently of the interaction potential or other thermodynamical parameters). All sequences of functions of an increasing number of variables (these functions are candidates for correlation functions) are considered for which an entropy per unit volume may be defined. These sequences are called correlation functionals and are investigated in detail. They prove useful to the study of the limit of an infinite system in statistical mechanics (thermodynamic limit). Furthermore, they allow the segregation of certain thermodynamic systems into phases. (auth)

14158 NEW MEASUREMENTS OF COMPARISON OF A CERTAIN NUMBER OF RADIUM STANDARDS. M. Lecoin and J. Robert (Universite, Paris). J. Phys., Phys. Appl. (Paris), 25: 159A-62A(Nov. 1964). (In French)

Measurements were made on the radium standard Hönigschmid 5427, which belongs to Russia. The mass defect of the international standard 5430 is confirmed. (auth)

14159 HIGH ENERGY PHYSICS RESEARCH AT CERN. Roger Anthoine. Nucl. Eng., 9: 439-44(Dec. 1964).

The goals of research at CERN and the present state of high-energy physics are briefly reviewed. The basic parameters of the synchrocyclotron and the synchrotron at CERN are described. Particle detectors — electronic counters and track chambers — are discussed. Work in the interpretation of experimental results is summarized. Contributions of CERN to the status of Western European research and to knowledge in fundamental physics are cited. Future possible developments in European high-energy physics are suggested. (M.J.T.)

14160 ON THE STATISTICAL MECHANICAL THEORY OF BROWNIAN MOTION. P. Mazur and E. Braun (Universiteit, Leiden). Physica, 30: 1973-88(Nov. 1964).

It is shown that a heavy particle in a one dimensional assembly of harmonic oscillators performs Brownian motion provided that the spectral density $G(\omega^2)$ of eigenvalues ω^2 of the interaction matrix is proportional to ω^{-1} for $\omega \to 0$. The interaction matrix may otherwise be completely arbitrary. A generalization of this result to D dimensional systems is given. (auth)

14161 THE PAIR DISTRIBUTION FUNCTION OF A DILUTE HARD SPHERE BOSE GAS. A. Isihara and D. D. H. Yee (Polytechnic Inst. of Brooklyn). Physica, 30: 2123-36(Dec. 1964).

Extending the theories of De Boer, Uhlenbeck, Yang and Lee and others, a quantum statistical mechanical formalism for evaluating the pair distribution function in terms of the binary kernel is presented. This formalism is more convenient for a hard sphere system than that recently developed by Fujita, Isihara and Montroll. An explicit evaluation of the pair distribution function of a hard sphere Bose gas at the lowest temperature is reported. The results improve upon those reported by Lee, Huang and Yang and others by using the pseudopotential. The normalization and divergence difficulties encountered by Fujita and Hirota are removed, and the correct interpretation of the results of Yang and Lee and others is given. The cause of the difficulties is discussed. A satisfactory result is obtained by taking tick-tack-toe diagrams into consideration in addition to the chain diagrams. (auth)

14162 SOME NEW USES AND IMPROVED INVESTIGATION METHODS FOR MAGNETIC NUCLEAR RESONANCE SPECTROSCOPY. THREE SPECTROMETERS FOR NUCLEAR MAGNETIC SOLIDS STUDIES. Justus Haupt, Werner Mueller-Warmuth, and Gerhard Schulz (Max-Planck-Institut für Chemie, Mainz). Z. Angew. Phys., 18: 132-9(Dec. 15, 1964). (In German)

The increasing significance of the magnetic nuclear resonance method for study of the properties of solids led to the development of new methods and apparatus. Three methods of investigation for different applications are described. The principal circuits and units of a highly sensitive absorption spectrometer, a self-adjusting bridge spectrometer, and a pulse spectrometer with temperature control are given and discussed. The signal forms differ significantly from each other in the three cases even when they yield comparable information. The applications are illustrated with examples. The measurement curves of the proton resonance in glasses, the saturation behavior of the ^{29}Si resonance, and proton resonance and relaxation in $(NH_4)_2HPO_4$ were considered. The instrumentation described can be applied to most problem areas in nuclear resonance studies in solids. (tr-auth)

14163 ON THE REFLECTION OF STRONG BLAST WAVES. Tien-sun Chang. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 134p.

The reflection of a strong blast wave against a rigid boundary is studied. The theory used is based on the continuum concept of flow of ideal gases. Methods of obtaining the upper and lower bounds of the position of the reflected shock $\bar{R}(t)$ as well as the acceleration of the shock wave separating two non-isentropic regions are described. The procedure of studying the associated flow properties across the reflected shock is also presented. The method of analysis used is to consider the change of properties along the reflected shock. Differential and integrated expressions are derived. They are then considered jointly with the general jump conditions across the reflected shock and the differential equations describing the flow properties in the regions ahead of and behind the shockfront. The method is applicable to a spherical, cylindrical, or planar reflection of a strong blast wave with a general adiabatic index $\gamma = c_p/c_v$, the ratio of the specific heats for constant pressure and volume processes. As an example, the reflection of a planar blast wave against a rigid wall is given and discussed in detail. A Taylor series expansion method of determining the position of the reflected shock is described. The parabolic approximation of the upper bound of the reflected shock by retaining the first three terms of the Taylor series expansion near the wall of reflection for a planar wave is found to yield sufficiently accurate results. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14164 SPRAVOCHNIK PO TEPLOFIZICHESKIM SVOISTVAM GAZOV I ZHIDKOSTEI. (Handbook on the Thermophysical Properties of Gases and Liquids). N. B. Vargaftik. Moscow, Gosudarstvennoe Izdatel'stvo Fiziko-Matematicheskoi Literatury, 1963. 708p.

Detailed data are given on the thermophysical properties of the most important gases and liquids in technology. The volume, enthalpy, entropy, heat capacity, sound velocity, the heat of vaporization, surface tension, viscosity diffusion, thermal diffusion, and heat transfer are analyzed as well as Prandtl criterion for a wide range of temperatures and pressures. Individual substances, gaseous mixtures, and solutions for fuels and high temperature coolants are considered. Thermophysical properties of certain gases are investigated considering dissociation and ionization effects. (R.V.J.)

14165 ELEMENTY MAGNITNOI GAZODINAMIKI. (Elements of Magnetogasdynamics). L. E. Kalikhman. Moscow, Atomizdat, 1964. 422p.

A general review is given of magnetogasdynamics. The basis equations and boundary conditions, properties of ionized gases, basic criteria of similarity, one-dimensional stationary flow of plasma in crossing electric and magnetic fields, propagation of perturbations in plasma, ionized gas motion without dissipation, shock waves in plasma, two-dimensional motion of plasma in a channel, and nonstationary motion of plasma are discussed. Hydrodynamic instability of plasma, equations for two-temperature magnetogasdynamics, and practical applications of magnetogasdynamics are also investigated. (R.V.J.)

Accelerators

Refer also to abstracts 13863, 13866, and 14308.

14166 (AED-C-18-03) ACCELERATORS. Series C: Bibliographies. W. Mausberg, comp. (Frankfurt am Main. Universität. Institut für Kernphysik). Aug. 1964. 97p. Dep.(mn).

A total of 341 references is presented on nuclear-physical accelerator installations up to 500 Mev. Author, report, patent, and subject indexes are included. (D.L.C.)

14167 (BNL-8561) MODEL MEASUREMENTS AND CORRECTION OF BEAM LOADING EFFECTS IN PROTON LINACS. S. Giordano (Brookhaven National Lab., Upton, N. Y.). Oct. 26, 1964. Contract AT-30-2-GEN-16. 23p. (CONF-650-12). Dep.(mn); $2.00(cy), 1(mn) OTS.

From Linear Accelerator Conference, Stoughton, Wis., July 1964.

Beam-loading effects are measured in proton linac models, and the magnitudes of the effects are compared for two linac structures having different bandwidths. The steady state is assumed, as is the uniform distribution of beam loading within a cavity. (T.F.H.)

14168 (BNL-8676) COMPARISON OF 500-Mev INJECTORS FOR THE BROOKHAVEN AGS. E. D. Courant (Brookhaven National Lab., Upton, N. Y.). Dec. 2, 1964. Contract AT-30-2-GEN-16. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

General requirements are formulated for 500-Mev proton injector for the Brookhaven AGS, as regards phase-space density, phase-space matching, and space-charge limits. Several concepts for producing 500-Mev proton pulses containing 2×10^{13} protons per pulse are described. Each concept uses a circular accelerator. The compatibility of each of the concepts with the general requirements is investigated. (T.F.H.)

14169 (BNL-8782) R/Q MEASUREMENTS FOR DEFLECTING WAVEGUIDES. T. Ferbel and H. Hahn (Brookhaven National Lab., Upton, N. Y.). Dec. 30, 1964. Contract AT-30-2-GEN-16. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

R/Q measurements are carried out for an iris-loaded waveguide by changing the waveguide into a resonant cavity (by introduction of short-circuiting end plates at properly chosen symmetry planes), and introducing a perturbing object (a needle) into the cavity. Variation of the stored energy as a function of the position of the needle in the cavity yields the R/Q value. The R/Q value can then be used to calculate the performance of the waveguide as a beam deflector for an accelerator. (T.F.H.)

14170 (BNL-8790) CAPACITOR CHARGING SYSTEMS. H. R. Shaylor and J. F. Sheehan (Brookhaven National Lab., Upton, N. Y.). Dec. 21, 1964. Contract AT-30-2-GEN-16. 47p. Dep.(mn); $2.00(cy), 2(mn) OTS.

The design of a capacitor charging system for use in the beam injector of the Brookhaven AGS is described. The system is required to produce about 100 Mw of r-f power at 0.6% duty cycle, giving an average of 600 kw. (T.F.H.)

14171 (CERN-64-43) ETUDE D'UNE CLASSE D'ONDES ELECTROMAGNETIQUES GUIDEES: LES ONDES EH. APPLICATION AUX STRUCTURES DEFLECTRICES POUR LES SEPARATEURS A ONDE PROGRESSIVE DE PARTICULES RELATIVISTES. (Study of a Class of Electromagnetic Wave Guides: the EH Waves. Application to the Deflecting Structures for Traveling-Wave Separators of Relativistic Particles). Y. Garault (Paris. Université, Orsay. Institut d'Electronique and European Organization for Nuclear Research, Geneva). 1964. 95p. Dep.(mn).

A systematic study is made of deflecting waves for fast particles and of structures used to guide them. A general study is first made of the wave guides parallel to an Oz axis in a homogeneous and isotropic medium. The EH waves are considered in cartesian coordinates and in circular cylindrical coordinates. The solutions of EH waves in the circular cylindrical guide with metallic iris were examined

with the aid of the ideal model with infinitely thin iris and of zero threshold. (J.S.R.)

14172 (DESY-64/13) EIN PHASENRÜCKKOPPLUNGS-SYSTEM ZUR DÄMPFUNG UND STABILISIERUNG VON PHASENSCHWINGUNGEN IN EINEM ELEKTRONEN-SYNCHROTRON. (A Phase Feed-Back System for Damping and Stabilizing of Phase Oscillations in an Electron Synchrotron). C. Passow (Deutsches Elektronen-Synchrotron, Hamburg). Dec. 1964. 37p. Dep.(mn).

A control system (phase feedback system) for stabilizing the r-f acceleration in an electron synchrotron is described. The system will also reduce the synchrotron oscillations of the accelerated particles. The control system is mainly designed for high energy and high current accelerators. Conditions for system stability are investigated. Usable parameters are obtained by digital computation. The nonlinear behavior of the system is measured with an analog computer. (auth)

14173 (JINR-P-1902) INTENSIVIYI PUCHOK MYUONOV SINKHROTSIKLOTRONA OIYAI. (An Intensive Muon Beam of the Joint Institute for Nuclear Research Synchrocyclotron). Yu. M. Grashin, B. A. Dolgoshein, V. G. Kirillov-Ugryumov, A. A. Kropin, V. S. Roganov, A. V. Samoilov, and S. V. Somov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 5p. Dep.(mn).

Preliminary data are presented on the muon beams obtained with the aid of the strong focusing tract of the synchrocyclotron. Brief information on the focusing lenses and the analyzing magnet of the tract is given, as well as that on the intensity, energy, composition, and the polarization of the muon beams. The muon beam with momenta of 130 Mev/c over 80 cm^2 is 3×10^4 sec^{-1}, the pion contamination being less than 0.4%. The beam polarization is (70 ± 20)%. (auth)

14174 (LNF-64/34) LE MISURE MAGNETICHE SUI MODELLI DEI MAGNETI E DEI QUADRUPOLI DI ADONE. (The Magnetic Measurements on the Model of the Adone Magnets and Quadrupoles). Note No. 250. M. Placidi (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). July 20, 1964. 75p. Dep.(mn).

The measurements made on models are illustrated. The results show the various intermediate phases around which are established the definitive characteristics of the ring. (tr-auth)

14175 (LNF-64/54) LIVELLI MEDI DI RADIAZIONE INTORNO ALL'ACCELERATORE LINEARE E ALL'-ANELLO DI ACCUMULAZIONE. (Mean Levels of Internal Radiation in the Linear Accelerator and the Storage Ring). Note No. 263. M. Bernardini (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Oct. 27, 1964. 27p. Dep.(mn).

A series of dosimetric calculations for the 400-Mev electron linear accelerator and for the 1500-Mev electron and positron storage ring that will be constructed at Frascati were reported. The results were compared with the specifications in the construction design. A calculation of radioactivity of the air in the tunnel of the linear accelerator was also performed. (tr-auth)

14176 (NP-14560) PROJEKT EINER FORSCHUNG-SANLAGE MIT EINEM BESCHLEUNIGER HOHER INTENSITÄT FÜR PROTONEN VON 500 Mev. (Design of a Research facility with a High-Intensity Accelerator for 500-Mev Protons). (Zurich. Eidgenössische Technische Hochschule). Jan. 1964. 56p. Dep.(mn).

The studies and development projects carried out at the Laboratory of High Energy Physics by the Cyclotron Planning Group up to the end of 1963 are summarized. The relation of the project to developments in Europe and the world, significance of elementary particle physics in present basic research, the research areas opened by the planned accelerator, the isochronous ring accelerator, and design development of the project with cost calculations are discussed. (J.S.R.)

14177 (ORNL-3722) THE SPACE, TIME, AND ENERGY DISTRIBUTIONS OF THE PROTON BEAM OF THE HARVARD UNIVERSITY SYNCHROCYCLOTRON. R. T. Santoro (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 37p. Dep.; $2.00(OTS).

The spatial distribution was estimated from multiple-scattering approximations and measured by means of x-ray films and a beam profile counter telescope. Experimental results may be approximated by a Gaussian function with $\sigma = \pm 0.28$ cm, with agreement between the observed results and the multiple-scattering estimates being favorable. Ninety-eight percent of the protons were contained in an 0.84-cm beam radius. Analysis of the macroburst structure revealed a gross duty cycle of (4 ± 2)%, depending upon proton injection and extraction parameters. Oscilloscope observations of the microstructure showed that the protons occurred at regular 42-nsec intervals, with the width of the time distribution of protons being less than 7 nsec. With the delayed coincidence technique, the standard deviation of the time between adjacent bursts of protons was 1.4 nsec. The proton beam energy was determined from measurements of the proton range in copper and from time-of-flight measurements. The beam energy determined from the range measurements was 160.3 ± 0.6 Mev. The rms range spread was measured from the differential range curve as 0.34 ± 0.05 g/cm^2, compared with the calculated straggling standard deviation of 0.32 g/cm^2. The proton energy measured by flight-time analysis over a 355-cm flight path was 153.38 ± 4.1 Mev. (auth)

14178 (SLAC-29) SPECIFICATIONS FOR THE BEAM TRANSPORT SYSTEMS TO END STATIONS A AND B. H. S. Butler, S. K. Howry, and C. H. Moore (Stanford Univ., Calif. Stanford Linear Accelerator Center). June 1964. Contract AT(04-3)-400. 68p. Dep.; $3.00(OTS).

Two beam-transport systems are designed for the Stanford Two-Mile Linear Accelerator. The systems' purpose is to deflect, momentum-analyze, and aim the beam toward one of two end stations. Both beam-transport systems are serviced by a single pulsed switching magnet. The specifications for the two beam-transport systems are summarized, as are the requirements that give rise to the specifications. (T.F.H.)

14179 (SLAC-PUB-52) THE STANFORD TWO-MILE LINEAR ELECTRON ACCELERATOR. R. B. Neal (Stanford Univ., Calif. Stanford Linear Accelerator Center). Sept. 1964. Contract AT(04-3)-400. 52p. (CONF-640900-1).

From American Vacuum Society Symposium, Chicago. Dep.(mn); $3.00(cy), 2(mn) OTS.

A description is given of the general aspects and vacuum systems of the Stanford two-mile electron linac. In addition, the site, construction, and supporting buildings are considered. (T.F.H.)

14180 (UCRL-11560) BEVATRON OPERATION AND DEVELOPMENT. JANUARY–MARCH 1964. Kenneth C. Crebbin, Robert Frias, William L. Everette, and Walter D. Hartsough (California. Univ., Berkeley. Lawrence Radiation Lab.). July 29, 1964. Contract W-7405-eng-48. 24p. Dep.; $2.00(cy), 1(mn) CFSTI.

The Bevatron provided beam for physics research 85% of the scheduled operating time. The study of high-intensity beam loss continued, with no conclusions made as to the cause. Changes in pole-face-winding currents increased the maximum accelerated beam to 5×10^{12} protons per pulse. Double pulsing of the rapid beam ejector was tried in preparation for simultaneous operation for two bubble-chamber experiments. One primary experiment finished and three new primary experiments were set up and started operation. Low rate of rise of magnetic field at low fields was tried, and the beam was successfully steered through this "mezzanine" region. Radiation background and activation studies continued at the Bevatron. (auth)

14181 (UCRL-11737) BEVATRON OPERATION AND DEVELOPMENT 42, APRIL THROUGH JUNE 1964. Kenneth C. Crebbin and William L. Everette (California.

Univ., Berkeley. Lawrence Radiation Lab.). Nov. 19, 1964. Contract W-7405-eng-48. 22p. Dep.; $2.00(OTS).

The Bevatron beam was on for 82% of the scheduled operating time. There were two scheduled shutdowns. The first was to inspect the bearings and journals of the main motor generator sets. The second shutdown was to relocate the K^- beam channel to the 72-inch hydrogen bubble chamber, to provide a lower-energy K^- beam. Four primary experiments were continued through this quarter. Four emulsion runs were made on primary time. Radiation detection and control studies continued. Decay-measurement studies of internal activation in the Bevatron were made during the shutdowns. Some viewing ports and pole-face-winding clamps were removed for studies of radiation damage. General building background and shielding studies were continued. (auth)

14182 (SLAC-Trans-13) EXPERIMENTS ON THE STORAGE OF ELECTRONS IN A SYNCHROTRON. Yu. M. Ado, E. (Ye.) G. Bessonov, and P. A. Cherenkov (Akademiya Nauk S.S.S.R. Institut Fiziki im. P. N. Lebedeva). Translated for Stanford Univ., Stanford, Calif. [1963]. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mn) JCL.

The lifetimes of electron beams stored in a 280-Mev synchrotron are measured experimentally. The effects of various parameters upon these lifetimes are investigated. The storage system under study utilizes an alternating guiding field. (T.F.H.)

14183 (UCRL-Trans-1174) ON COHERENT INSTABILITY OF BETATRON OSCILLATIONS IN ACCELERATORS AND ACCUMULATORS. V. I. Balbekov and A. A. Kolomenskii (U.S.S.R.). Translated by Sergey Shewchuck (Univ. of California, Lawrence Radiation Lab., Berkeley), from a 1964 Russian preprint. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

The problem of transverse instability is discussed for a beam of charged particles formed in the focusing system of a cyclic-type accelerator or accumulator. A dispersion equation is derived and studied for the coherent vertical oscillations of the beam's center of gravity. It is shown, in particular, that the finite conductivity of the vacuum chamber walls can lead to instability. Conditions to suppress the instability are pointed out. (auth)

14184 THE STABILITY OF ELECTRON BEAMS BY MAGNETIC FOCUSSING. Hans-Jochen Linn (Siemens & Halske AG, Munich). Arch. Elek. Uebertrag., 16: 381-4 (Aug. 1962). (In German)

The stability of electron beams in magnetic focussing in uniform and in space-periodic magnetic fields was investigated, and a measurement of the stability was made. A comparison of the magnitudes flux ratio, magnetic field strength, and beam radius was made in the two cases. An approximation formula for the smallest beam wrinkle occurring in the periodic field was derived. The investigation showed that the periodic focussing was at least equal, and generally superior, to uniform field focussing with respect to stability. (tr-auth)

14185 THE CONTROL OF ION BEAMS BY MEANS OF MAGNETIC FIELDS. Istvan Kovacs. Fiz. Szemle, 14: 270-8(Sept. 1964). (In Hungarian)

One of the most important problems encountered in the operation of accelerators involves directing the beam of accelerated ions onto the target. The beams may be focused by electrostatic means or by using magnetic fields; the latter method is more widespread because it may be employed for high-energy accelerators. The effect exerted by the magnetic field depends on the specific charge of the particles, e/m; therefore the particles follow paths of identical charge and are thus separated. As a result of this, the beam which reaches the target area is homogeneous as far as the mass of the component particles is concerned, facilitating greatly the evaluation of the results. The systems contain usually an analyzing magnet, the quadrupole lenses, and the distributing magnet. The ion-optics of these systems are closely examined. The analyzing magnet separates the accelerated particles according to their energy and their e/m ratio; the quadrupole lenses focus the beam and prevent its dispersion, while the distributing magnets direct the beam toward the various experimental assemblies, making it possible to prepare an experiment while carrying out measurement at a neighboring stand. (TTT)

14186 ON THE MEDICAL LINEAR ACCELERATOR. Hisao Yamashita. Gan no Rinsho, 9: 559-77(Oct. 1963). (In Japanese)

A brief history of the medical linear accelerator is given tracing the development of this tool. Theory and operation of this instrument are discussed briefly, and general operating characteristics of five different makes; Met. Vickers, Mullard, Vickers R., Varian, High Voltage are compared. The performance of one of the first linear accelerators in operation at Christie Hospital (Manchester) is cited, and attention is directed to the low loss in operating time as a result of malfunctioning. Maintenance problems are discussed with notations on replacement time for key parts. There is a brief discussion of dosimetry and relative dose distribution to a subject undergoing irradiation. Application of this instrument to cancer therapy is described along with some recent developments which enhance the utility of this tool. (TTT)

14187 EFFICIENCY OF SMOOTH-MODERATING WAVEGUIDE SYNCHROTRON SYSTEMS. A. N. Didenko and V. P. Grigor'ev (Kirov Polytechnic Inst., Tomsk, USSR). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 16-20(1964). (In Russian)

The question is considered of the efficiency of waveguide synchrotrons in which smooth curving waveguides of rectangular cross section are used for acceleration. It is shown that for determined conditions the efficiency of such accelerating systems is comparable to that of accelerating systems of the diaphragming-waveguide type and higher than that of resonator systems. (tr-auth)

14188 PARTICLE MOTION IN A STRONG FOCUSING WAVEGUIDE SYNCHROTRON. Yu. P. Bulychev and A. N. Didenko (Kirov Polytechnical Inst., Tomsk, USSR). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 20-8(1964). (In Russian)

A study is made of the motion of particles in a strongly focusing waveguide synchrotron with a high-frequency field of the type LH (longitudinal magnetic). Conditions of stability of motion with radiation emission are found. (tr-auth)

14189 ON AN RF ION SOURCE OF LONG MEANLIFE. Laszlo Vályi, Peter Gombos, and Jozsef Roósz. Magy. Tud. Akad. Kozp. Fiz. Kut. Inst. Kozlemen., 12: 461-76 (1964). (In Hungarian)

The features of a low-intensity radiofrequency ion source, having a discharge tube without electrode, were investigated. The characteristics of the ion current extracting voltage were measured for various distances between the spherical-geometry electrodes. The curves exhibit two portions of different behavior, one varying with $V^{\frac{3}{2}}$, the other linearly. Composition and standard deviation in energy of the extracted ion beam were determined. For 2 kv extracting voltage, the standard deviation was found to be 42 ev and the proton fraction 70%. For ion current of 30 μamp the gas consumption rate is ~3–4 cm/hr, with mean life more than 300 hr. (auth)

14190 MAGNETIC FOCUSING SYSTEMS FOR HIGH-ENERGY PARTICLES. V. V. Miller (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 6, 3-23(Nov.-Dec. 1964). (In Russian)

A survey is made of various magnetic focusing systems for high-energy particle beams. Simple magnetic systems and systems with many lenses and magnets are described, and their performance is analyzed. (R.V.J.)

14191 ACCELERATING FIELD FOCUSING. V. A. Teplyakov. Pribory i Tekhn. Eksperim., No. 6, 24-7(Nov.-Dec. 1964). (In Russian)

A design is given of a drift tube (with two symmetric planes) which affords a more efficient accelerating field focusing. (R.V.J.)

14192 SWITCHING OF 1.5-m IAE CYCLOTRON TO ION-CONTROLLED OPERATION. A. V. Antonov, P. I. Vasil'ev, N. I. Venikov, S. P. Kalinin, N. I. Sokolov, N. N.

Khaldin, B. I. Khoroshavin, and N. I. Chumakov (Inst. of Atomic Energy, Moscow). Pribory i Tekhn. Eksperim., No. 6, 28-9(Nov.-Dec. 1964). (In Russian)

Descriptions are given of changes of resonance lines and correction windings required for switching a 1.5 m cyclotron to a fast ion controlled operation retaining +0.3 to 0.4% beam monoenergy and short duration (2 to 4 nsec) clusters of accelerated ions. (R.V.J.)

14193 REDUCED FREQUENCY OF ION CLUSTERS IN THE IAE CYCLOTRON. A. V. Antonov, M. V. Blokhov, N. I. Vennikov, S. P. Kalinin, A. A. Kurashov, P. E. Petrov, and A. A. Chesalov (Inst. of Atomic Energy, Moscow). Pribory i Tekhn. Eksperim., No. 6, 30-2(Nov.-Dec. 1964). (In Russian)

A device for reducing the frequency of ion clusters by a factor of four in a cyclotron is described. The ions are deflected by a high-frequency sinusoidal voltage applied to a special deflecting system located in the ion conductor. Formulas were derived for calculating the shape of electrodes in the deflecting system and the required high-frequency voltage between them. A schematic and a short description of the device are presented. (tr-auth)

14194 PULSED NEUTRON GENERATOR OF TOKAI UNIVERSITY. Masatsugu Ishida and Shozo Nakadoi (Tokai Univ., Japan). Proc. Fac. Eng. Tokai Univ., No. 2, 15-23 (Mar. 1964). (In Japanese)

The Cockcroft-Walton type accelerator is used in two ways: one is to generate continuously about 10^{10} n/sec at 14 Mev at the maximum yield by reactions D(d,n) ^{3}He or T(α,n) ^{4}He with accelerated deuterons, and the other is to obtain pulsed neutrons with 0.1 to ~500 μsec pulse width by pulsing electrostatically accelerated deuteron beams or by accelerating pulsed deuteron beams. Its principle, use, construction, and properties are reported. (auth)

14195 FIRST- AND SECOND-ORDER MAGNETIC OPTICS OF A CIRCULAR-POLE UNIFORM-FIELD MAGNET. PART I. K. L. Brown (Stanford Univ., Calif.). Rev. Sci. Instr., 36: 271-4(Mar. 1965).

The first- and second-order optics of a uniform-field circular-pole magnet were calculated, using the impulse approximation for the fringe-field effects. From this, the first- and second-order resolution was derived over the entire focal plane of the magnet as a function of the angle of deflection and the momentum of the particle. (auth)

14196 A SPIRAL LINEAR ACCELERATOR WITH ELECTRONS AS A MODEL OF A PROTON ACCELERATOR. Horst Klein (Universität, Frankfurt am Main). Z. Angew. Phys., 18: 143-9(Dec. 15, 1964). (In German)

On the basis of theories recently developed at the University a study was made to determine the extent to which these theories would permit the construction of a good functioning spiral linear accelerator and what acceleration properties are to be expected. A 3-m spiral linear accelerator for proton acceleration from 6.8 to 10.4 Mev was calculated and constructed. In this accelerator electrons, instead of protons, were accelerated in the same velocity interval, i.e., from 3.7 to 5.66 kev. The high-frequency power was thus reduced by a factor of 3×10^{-7} and an axial magnetic field was sufficient for focussing. In spite of these and other simplifications, the electrons behaved in acceleration just as protons accelerated over the same velocity range. The energy distributions measured with the counter-field method were completely analogous to the spectrum of the corresponding protons. Capture range and energy distribution of the accelerated particles were experimentally studied for dependence on input energy, frequency, and high-frequency power. It was found that the spiral linear accelerator in operation is very uncritical: change of the frequency by 10% and the input energy by 5% caused only trivial deformations of the energy spectrum. Comparison of the measured energy spectrum with that calculated on the basis of the phase oscillations gave a very good agreement both in their form and the site of the energy scale and with respect to the capture range. Therefore the relation between the high-frequency power and the axial electric field strength assumed in the solution of the development problem was correct in the limits of the measurement accuracy. It was concluded that a spiral linear accelerator developed on the theoretical bases used here can be calculated sufficiently accurately, is relatively simple in construction, and is uncritical in operation. The capture range and the energy sharpness of the accelerated protons can be increased by bunching and debunching tubes. (tr-auth)

14197 ON THE HIGH-FREQUENCY TECHNOLOGICAL CHARACTERISTICS OF A SPIRAL LINEAR ACCELERATOR FOR PROTONS IN THE ENERGY REGION FROM 0.15 TO 1 Mev. Friedrich Saure (Universität, Frankfurt am Main). Z. Angew. Phys., 18: 150-2(Dec. 15, 1964). (In German)

Construction of the acceleration section of a spiral linear accelerator, which operates at sufficient mechanical stability with very little support material for the wave guide, is described. HF measurements were made on the acceleration section. The accelerating electrical field strength could be measured directly with an electrometer measuring device. For comparison with the measurements the laminated model was referred to. The measurements showed that the spiral linear accelerator, at an acceleration gap of 4.80 m and at an operating frequency of 20 MHz, needs a transmitter power of only 10 kw to accelerate protons from 0.15 to 1 Mev. (tr-auth)

14198 ON THE DIMENSIONING OF QUADRUPOLE LENS IN A LINEAR ACCELERATOR. Peter Junior (Universität, Frankfurt am Main). Z. Angew. Phys., 18: 152-7(Dec. 15, 1964). (In German)

Dimensioning of the quadrupole as focusing lens is not considered very critical in the optical approximation presented with respect to the mathematical stability of radial particle motion. The stability width shrinks significantly when the small apertures of the accelerator and quadrupole are considered and also under the best possible input conditions. For calculation of the actual orbits, the laminated model, which describes these orbits only through a very coarse polygonal course, is considered a bad approximation. A simple lens model can be given for the symmetrical triplet. Consideration of this model, which leads to diagrams similar to those illustrated, was not undertaken in the present study. It is shown how the matrix method in connection with stability criteria for the optical models rapidly yields estimations for the accelerating lens. (tr-auth)

Astrophysics and Cosmology

Refer also to abstracts 14281, 14424, and 14432.

14199 (MIT-2098-99) X-RAY AND GAMMA-RAY ASTRONOMY. Bruno Rossi (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Nov. 24, 1964. Contract AT(30-1)-2098. 28p. (CONF-521-3). Dep.(mn); $2.00(cy), 1(mn) OTS.

From 5th Space Science Symposium, Florence, May 1964.

Experimental results in gamma and x-ray astronomy are outlined, and their theoretical interpretations are discussed. (T.F.H.)

14200 (UCRL-12191) MECHANISM OF TYPE II SUPERNOVA EXPLOSIONS. Stirling A. Colgate and Richard H. White (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 16, 1964. Contract W-7405-eng-48. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A mechanism for type II supernova explosions, which transfers the energy of the collapsing core to the outer layers to blow them off, is discussed. Such a mechanism is found in the very-high-energy thermal neutrinos that are emitted from the high-temperature-core shock wave. These neutrinos have a mean free path less than the stellar radius. (C.E.S.)

14201 NEUTRINO PROCESSES AND PAIR FORMATION IN MASSIVE STARS AND SUPERNOVAE. William A.

Fowler and F. Hoyle (California Inst. of Tech., Pasadena and Cambridge Univ., Eng.). Astrophys. J., 9: Suppl. Ser., No. 91, 201-319(Dec. 1964).

The physical properties of matter inside highly evolved stars are traced, on the assumption that the whole material of the star is non-degenerate and that the star is in quasi-hydrostatic equilibrium. When these conditions are satisfied, the physical evolution of a particular element of material is insensitive to the stellar model, but not to the total mass of the star. Stars of mass greater than $\sim 10\ M_\odot$ but less than $\sim 10^6\ M_\odot$, at which point general relativistic considerations become paramount, are considered. Neutrino-loss processes and rates are examined. It is concluded that $e^- + e^+ \rightarrow \nu + \bar{\nu}$ is the most important neutrino process in massive stars. A method is developed for calculating the product $\mu\beta$ as a function of temperature when electron-positron pair formation is taken into account. In this product μ is the mean molecular weight and β the ratio of gas pressure to gas plus radiation pressure. The results are used to derive relations of the form $\rho \propto (M_\odot/M)^2(T/\mu\beta)^3 \propto (M_\odot/M)^{\frac{1}{2}}T^3$ for massive stars. The internal energy of matter is considered, again as a function of temperature and including the effects of pair formation. Nuclear reactions, particularly oxygen burning, the α-process, and the e-process are also treated. The onset of a supernova of Type II in which the central core implodes while the mantle and envelope of the star explode is considered. It is emphasized that massive stars do not necessarily become Type II supernovae but can collapse to general relativistic singularities. The case in which some form of braking mechanism, such as rotation, internal turbulence, or an entrained magnetic field, leads to core implosion followed by mantle-envelope explosion is also studied. (auth)

14202 PROCEEDINGS OF THE CONFERENCE ON ARTIFICIAL SATELLITES: AUGUST 12 THROUGH AUGUST 16, 1963. Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser., 57: No. 8, Pt. B, 282p.(Aug. 1964). (CONF-630801(Pt. B))

Separate abstracts were prepared for two of the ten papers included. The remaining papers deal with communication satellites, planetary atmospheres, the Tiros satellite, the Nimbus spacecraft, and orbiting observatories. (D.C.W.)

For abstracts of individual papers see: 14203 and 14204.

14203 SOLAR AND STELLAR RADIATIONS ABOVE THE EARTH'S ATMOSPHERE. Talbot A. Chubb (Naval Research Lab., Washington, D. C.). Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser., 57: No. 8, Pt. B, XII1-21(Aug. 1964).

Some experimental observations on solar and stellar radiations are summarized, and the implications for the nature of the sun and stars are considered. (D.C.W.)

14204 SOLAR FLARES AND THE ASSOCIATED EJECTION OF PARTICLES. Einer Tandberg-Hanssen (High Altitude Observatory, Boulder, Colo.). Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser., 57: No. 8, Pt. B, XV1-8(Aug. 1964).

Solar flares are briefly described; and flare-associated phenomena, particularly the emission of particles, are discussed. Theory for flare formation is considered, together with the possibility of predicting flares. (D.C.W.)

14205 THE SOLAR AND EXTRAGALACTIC RED SHIFTS. A. H. Gillieson. Can. J. Phys., 43: 57-73(Jan. 1965).

A photon model is postulated whereby the peculiar nature of the observed solar red shift is explained, and by which the extragalactic red shifts are interpreted as caused not by the Doppler effect, but by interaction and consequent loss of energy of the photon in passing through the inhomogeneities of the gravitational field in space. (auth)

14206 SEARCH FOR ALUMINUM-26 IN DUST FROM THE GREENLAND ICE SHEET. Edward L. Fireman and Chester C. Langway, Jr. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Geochim. Cosmochim. Acta, 29: 21-7(Jan. 1965).

Large volumes of approximately 250-year-old Greenland glacier ice were filtered. Approximately 20,000 liters passed through 0.45 μ retention paper with a 2.5 ft surface area, and approximately 200,000 liters passed through 3μ retention paper. Less than 4×10^{-7} dpm/l of ^{26}Al was found in the 3 μ collections, and less than 3×10^{-6} dpm/l in the 0.45 μ collection. These limits were significant for determinations of exposure age, chemical composition, and accretion rate of extraterrestrial dust. For an accretion rate for the Earth of a million tons per year of silicates, the limit of 4×10^{-7} dpm/l corresponds to an exposure age of 4000 years. Although the filter collections did not contain ^{26}Al, they did contain radioactivities. The principal one was ^{208}Tl, a thorium decay product attributed to terrestrial material in the collection. There was also a small positron activity, which disappeared with the purification of aluminum. (auth)

14207 ON SOME TANTALUM ABUNDANCES IN METEORITES AND TEKTITES. William D. Ehmann (Univ. of Kentucky, Lexington). Geochim. Cosmochim. Acta, 29: 43-8(Jan. 1965).

Tantalum abundances, or upper abundance limits, were determined by neutron activation analysis in 10 chrondrite specimens, 3 achondrites, 3 siderites, 1 specimen of meteoritic olivine, 1 specimen of meteoritie troilite, 4 tektites, 1 impact glas, 1 soil specimen from a tektite occurrence, and 1 deep-sea sediment. The chondritic tantalum abundance of 0.021 ppm found was in good agreement with the value of 0.023 obtained by Atkins and Smales (1960). The similarity of tantalum abundances in tektites to those in common terrestrial materials was noted. (auth)

14208 SOME PERIODIC SOLUTIONS OF A FOUR-BODY PROBLEM. Jane Cronin, Paul B. Richards, and Lawrence H. Russell (General Precision, Inc., Little Falls, N. J. and Polytechnic Inst. of Brooklyn). Icarus 3: 423-8 (Dec. 1964).

A four-body problem which is a model for the motion of a particle or vehicle in the Sun-Earth-Moon system is obtained by rotating the barycenter B of the two massive bodies in a restricted three-body configuration about a third massive body. It is shown that this problem can be regarded as a perturbation of the restricted three-body problem where the perturbation parameter is the mass of the third body divided by the cubed distance from the third body to B. It is proved that under certain conditions, especially with a restriction on the magnitude of the perturbation parameter, the particle of negligible mass has a periodic motion near each of the libration points of the restricted three-body problem; a method for estimating the restriction on the magnitude of the perturbation parameter is described. (auth)

14209 COSMIC-RAY-INDUCED PARTICLE TRACKS IN A METEORITE. M. Maurette (Université, Paris), P. Pellas, and R. M. Walker. Nature, 204: 821-3(Nov. 28, 1964).

Observations of cosmic-ray induced particle tracks in samples of meteoritic material are reported. The problem of theoretical interpretation is discussed, and it is concluded that the majority of the observed tracks come either from spallation recoils or heavy primary ions. Additional experiments which should serve to solve completely the problem of track origin are indicated briefly. (C.E.S.)

14210 GRAVITATIONAL COLLAPSE. W. B. Bonner (Univ. of London). Nature, 204: 868(Nov. 28, 1964).

The gravitational contraction of large spherically symmetric masses is considered. It is pointed out that a relativistic solution exists for a static pressure-free sphere of arbitrary size and mass provided that the matter carries an appropriate electric charge. This is the counterpart of the classical solution in which gravitational attraction and electric repulsion just balance. (C.E.S.)

14211 GRAVITATIONAL COLLAPSE. E. R. Harrison (National Inst. for Research In Nuclear Science, Chilton, Berks, Eng.). Nature, 204: 1179-80(Dec. 19, 1964).

A theoretical discussion of the ultimate fate of gravitational collapse of large masses is presented. It is concluded that in an external system, consideration of the ultimate fate of bodies that are gravitationally collapsing is meaningful if the universe is oscillating because the

external system itself participates in the final stage of the gravitational collapse. (J.R.D.)

14212 ABUNDANCE ANALYSIS OF A SUPERGIANT IN THE LARGE MAGELLANIC CLOUD. Antoni Przybylski (Australian National Univ., Canberra). Nature, 205: 163 (Jan. 9, 1965).

A good spectrum of the brightest member of the Large Cloud, HD 33579, was obtained. The effective temperature was estimated from previous measurements. A coarse analysis of the spectrum was carried out using Wrubel's curve of growth for four different reciprocal temperatures, and the results are given. The same procedure was repeated for α Cygni, in order to check the gf values used in the calculations. Results are given for both computations for electron density and abundances of H, Fe, Cr, and Ti. (M.J.T.)

14213 POLARIZATION OF JOVIAN EMISSION AT DECAMETRE WAVE-LENGTHS. William M. Sherrill (Southwest Research Inst., San Antonio). Nature, 205: 270-1(Jan. 16, 1965).

During the period Sept. 1-Dec. 31, 1963, observations of the polarization of radio-wave emission from Jupiter were made at 15.2, 16.2, 18.2, 22.2, and 24.2 Mc/s. A two-helix polarimeter, utilizing a twin channel receiver, was expanded so that determination of the cross-correlation of the right and left circular components, in addition to the two opposite circular components, was made separately for each Jupiter burst. The calibrated polarimeter thus provided determination of the polarization fraction (m), axial ratio (r) and sense of the Jupiter bursts observed. The results indicate consistent values of burst axial ratios independent of System III (1957) longitude. This and the observed dependence of $\Sigma|r|$ on N are both consonant with the cyclotron source model within experimental error. (P.C.H.)

14214 MASS SPECTROSCOPY OF THE SMALLEST QUANTITIES OF MATTER IN NUCLEAR PHYSICS AND ISOTOPE COSMOLOGY. H. Hintenberger (Max-Planck-Institut fur Chemie, Mainz). Naturwissenschaften, 51: 497-503(1964). (In German)

The bibliographic review of current studies and knowledge on the mass spectroscopy of the smallest quantities of matter in nuclear physics is concluded. The cosmology of isotopes is considered with respect to their geological distribution and distribution in meteorites. (88 references). (J.S.R.)

14215 PROBLEM OF ENERGY IN AN EXPANDING UNIVERSE. Jaroslav Pachner. Phys. Rev., 137: B1379-84(Mar. 8, 1965).

It is proved that a plausible definition of the total energy of a body in Newtonian cosmology can be given by the condition that the energy is conserved, if the body is participating in the general cosmic expansion. The same formula for the total energy results also from a certain metric describing a relativistic model of a universe with a uniform and isotropic distribution of matter and distinguished by an interesting property: that the differences of space-like coordinates have in it an immediate metric meaning as the lengths measured by rigid rods. It is found that the cosmic expansion has either no effect, or quite imperceptible effects on the motion of planets in our solar system, but during the formation of local systems such as clusters of galaxies, the deviations from the exact validity of the conservation law of energy are of considerable magnitude. This process is to be studied on the basis of McVittie's model. (auth)

14216 SPHERICALLY SYMMETRIC DISTRIBUTIONS OF MATTER WITHOUT PRESSURE. Guy C. Omer, Jr. (Univ. of California, Los Angeles). Proc. Natl. Acad. Sci. U. S., 53: 1-5(Jan. 1965).

The behavior of spherically symmetric distributions of matter without pressure is analyzed with consideration of several types of cosmological models. (D.C.W.)

14217 THE CRITICAL POINT OF NUCLEAR MATTER. M. Nagazaki. Soryushiron Kenkyu, 26: 289-97(1962). (In Japanese)

The pressure and temperature at which the nuclear matter in the gas phase equilibrates with that in liquid phase in the cooling process are calculated under the assumption that alpha particles are the only notable nucleon clusters appearing in the cooling process. The nucleon density and the mean separation of the alpha particles at the critical point are also obtained. (D.C.W.)

14218 NATURE OF SOLAR X-RAY EMISSION. I. S. Shklovskii (Shternberg State Astronomical Inst., USSR). Soviet Astron. AJ (English Transl.), 8: 538-44(Jan.-Feb. 1965). Translated from Astron. Zh., 41: 676-83(July-Aug. 1964).

It is shown, on the basis of an analysis of simultaneous observations of x-ray emission, the coronal lines Fe XV and Fe XVI, and radio emission at 10.7 cm, that a coronal temperature of $\approx 1.5 \times 10^6$ is sufficient to account for the x-ray emission of the quiescent sun. The x-ray emission of flares is accounted for by the reverse Compton effect on relativistic electrons of $\approx 10^7$ to 10^8 ev moving in the solar radiation field. The total energy associated with these electrons must be $\approx 10^{30}$ erg or less in the region of a flare (if the emission density of L_α-quanta trapped in the flare region is sufficiently high). (auth)

14219 TWO-COMPONENT MODEL OF THE SOLAR SUPERCORONA. V. V. Vitkevich (Lebedev Inst. of Physics, Moscow). Soviet Astron. AJ (English Transl.), 8: 545-50 (Jan.-Feb. 1965). Translated from Astron. Zh., 41: 684-91 (July-Aug. 1964).

Optical and radio data on the decrease of electron concentration in the solar supercorona within the distance limits of 5 to 20 $R_\odot$ are compared. It is found that the index of decrease with distance for an average electron concentration obtained from optical data is appreciably larger than that found from radio data at distances of 5 to 10 $R_\odot$. At distances of 12 to 15 $R_\odot$ the values are approximately the same. The two-component structure of the solar supercorona follows from these results. The first component is diffuse with a comparatively uniform distribution of electron concentration and rapidly decreasing electron density. The second component is radial with a predominantly radial structure of nonuniformities and a slow decrease of electron concentration. The first component is probably in a state of hydrostatic equilibrium and is penetrated by the second component (radial) with a flow of plasma along rays limited by a predominantly radial magnetic field. The flow of plasma in the form of rays is responsible for the solar wind observed near the earth. (auth)

14220 CUMULATIVE EFFECTS IN COMETS. L. S. Marochnik (Inst. of Astrophysics, Academy of Sciences, Tadzhikskaya SSR). Soviet Astron. AJ (English Transl.), 8: 583-5(Jan.-Feb. 1965). Translated from Astron. Zh., 41: 733-7(July-Aug. 1964).

The interaction of the solar wind with magnetized plasma in a cometary head is considered. It is shown that due to the increase in the magnetic field between the peripheral parts of the comet and the nucleus, there is an increase in the density of solar plasma penetrating the comet. Cumulation of density and solar-wind energy accounts for the ionization observed in comets. In some cases cumulation of this kind seems to be the cause of halo formation. (auth)

14221 SOLAR MAGNETIC FIELDS. A. Severny (Crimean Astrophysical Observatory, Academy of Sciences, Crimean, USSR). Space Sci. Rev., 3: 451-86(Nov. 1964).

A review of observational knowledge on solar magnetic fields is presented. An attempt is made to summarize all observations of the general magnetic field (m.f.) of the Sun. The local m.f. at low latitudes and their connection with some features on the disk are discussed. The m.f. of sunspots and their peculiar character are considered. The magnetic field in sunspot groups, their changes, and connections with solar activity are also considered. (auth)

14222 GENERATION, PROPAGATION AND DETECTION OF RELATIVISTIC SOLAR PARTICLES. J. G. Roederer (Centro Nacional de Radiacion Cosmica, Buenos Aires). Space Sci. Rev., 3: 487-511(Nov. 1964).

The processes of generation, propagation, and detection of relativistic solar particles are discussed. The problem of how to connect the unknown solar particle flux, energy spectrum, and angular distribution in space to measurements made on the earth's surface. Experimental information about properties of high energy particle fluxes in space are analyzed, and comments are made on the flare acceleration mechanism. (C.E.S.)

14223 ORIGIN, AGE, AND COMPOSITION OF METEORITES. Edward Anders (Univ. of Chicago and Universitat, Bern). Space Sci. Rev., 3: 583-714(Dec. 1964). (COO-382-47)

An attempt is made to bring together and evaluate all significant evidence on the origin of meteorites. The iron meteorites seem to have formed at low pressures. Laboratory evidence shows that the absence of a Widmanstätten pattern in meteorites with >16% Ni cannot be attributed to high pressures, but to supercooling or an unusually fast cooling rate for these meteorites, which prevented the development of a pattern. The presence of tridymite in the Steinbach siderophyre provides further, direct proof that the Widmanstätten pattern can form at pressures less than 1 kb. Neither diamond, nor cliftonite, nor cohenite is reliable pressure indicators in meteorites. Diamonds were formed by shock while cliftonite may have been derived from a cubic carbide such as Fe_4C. Cohenite is apparently stabilized by kinetic rather than thermodynamic factors. Several lines of evidence suggest that the irons come from more than one parent body, perhaps as many as four. The frequency of pallasites is perfectly consistent with an origin in the transition zone between core and mantle of the parent body. Hybrid meteorites such as Brenham are not necessarily derived from the metal-silicate interface, but probably resulted from dendrite growth in the solidifying melt. Ordinary chondrites definitely are equilibrium assemblages rather than chance conglomerates. According to the best available evidence, Prior's rules seem to be valid. The metal particles in chondrites differentiated into kamacite and taenite in their present location, rather than in a remote earlier environment. Trace element abundances in ordinary and carbonaceous chondrites suggest that these meteorites accreted from two types of matter: an undepleted fraction that separated from its complement of gases at low temperatures, and a depleted fraction that lost its gases at high temperatures. These two fractions of primitive meteoritic matter are tentatively identified with the matrix and chondrules-plus-metal, respectively. New restrictive limits are placed on the iron-silicate fractionation in chondrites. No direct evolutionary path exists that connects the currently accepted solar abundances of Fe and Ni and the observed Fe/Si and Ni/Si ratios in chondrites. Apparently the solar abundance of iron is in error. The iron-silicate fractionation seems to have occurred while chondritic matter was in a more strongly reduced state than its present one. The U-He and K-Ar ages of hypersthene chondrites are systematically shorter than those of bronzite chondrites. Short ages are correlated with shock effects, and it seems that the hypersthene chondrites suffered reheating and partial-to-complete outgassing 0.4 AE ago. The cosmic-ray exposure ages of all classes of meteorites cluster distinctly, indicating that the meteorites were produced in a few discrete major collisions rather than by a quasi-continuum of smaller ones. The dates of the principal breakups are: irons, 0.6 and 0.9 AE; aubrites, 45 m.y.; bronzite chondrites, 4 m.y.; hypersthene chondrites, 0.025, 1, 7-13, and 16-31 m.y. All four clusters of hypersthene chondrites show evidence of severe outgassing 0.4 AE ago, which implies that most or all hypersthene chondrites come from the same parent body. As already noted by Signer and Suess, two distinct types of primordial gas occur in meteorites. Differentiated meteorites always contain unfractionated gas, while relatively undifferentiated meteorites contain fractionated gas. The former component is invariably associated with shock effects, and seems to have been derived from the solar wind. The latter component is correlated with other volatiles and seems to be a truly primitive constituent of meteoritic matter. Isotopic anomalies in the fractionated gas suggest that meteoritic matter was irradiated with $\geq 10^{17}$ protons/cm^2 at a very early stage of its history. There is very little doubt that most, if not all, meteorites come from the asteroid belt rather than from the moon. The orbits and geocentric velocities of stony meteorites resemble those of the Apollo asteroids (most of which are former members of the asteroid belt that have strayed into terrestrial space), but disagree strongly with the calculated orbits and velocities for lunar ejecta. Öpik's conclusions about the difficulty of accelerating lunar debris to escape velocity represent a further argument against a lunar origin of stony meteorites. The most likely parent bodies of the meteorites are the 34 asteroids which cross the orbit of Mars. Collisional debris from these objects will remain in Mars-crossing orbits, and perturbations by Mars will inject some fraction of this material into terrestrial space. Most of the Mars asteroids, comprising 98% of the mass and 92% of the cross section, belong to three Hirayama families (Phocaea, Desiderata, and Aethra), and an additional, previously unrecognized family. These families were apparently produced by disruption of parent asteroids ~104, 105, and 46 km in diameter. The size distribution and light curves of asteroids indicate that the larger asteroids are original accretions, rather than collision fragments. There is no reason to believe that the meteorites ever resided in bodies larger than Ceres (d = 770 km). Various theories on the origin of the meteorites are critically reviewed in the light of the preceding evidence. Wood's theory, which postulates a high-temperature and a low-temperature variety of primordial matter, is in best accord with the evidence. Apparently the asteroids accreted from varying proportions of these two types of material, and were then heated by extinct radioactivity produced in the early irradiation. (auth)

14224 OPTICAL FOCUSSING WITH SOFT X-RAYS AND IN THE EXTREME ULTRAVIOLET. U. Mayer (Universitat, Tubingen, Ger.). Space Sci. Rev., 3: 781-815(Dec. 1964).

Focusing systems for the vacuum uv radiation of the sun and other celestial bodies are discussed. A description of focusing systems for different ranges of x-ray wavelength is presented, and detector and filter techniques are outlined. Optical focusing in the vacuum uv above 500 Å and in the extreme uv below 500 Å is considered. (C.E.S.)

14225 DEVELOPMENT OF INVESTIGATIONS IN RADIOASTRONOMY AT THE LABORATORY OF THE INST. OF PHYSICS OF THE ACADEMY OF SCIENCES. V. V. Vitkevich. Tr. Fiz. Inst., Akad. Nauk SSSR, 17: 3-12(1962). (In Russian)

Research at the Lebedev Institute on radio emission by the sun and by discrete galactic sources is described, together with two radiotelescopes. (D.C.W.)

14226 ON THE SUPERFLUIDITY OF NEUTRON STARS. V. L. Ginzburg and D. A. Kirzhnits (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 2006-7(Nov. 1964). (In Russian)

Previous investigations of the gravitational collapse and x-ray emission of neutron stars are discussed. The neutron star is considered as a Fermi gas and the conditions for superfluidity are discussed. (C.E.S.)

14227 COSMOLOGY AND ELEMENTARY PARTICLES. D. F. Kurdgelaidze (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 2313-14(Dec. 1964). (In Russian)

It is pointed out that the connection between cosmological and local properties of elementary particles must be taken into consideration when constructing a theory of elementary particles, since it is not excluded that phenomena on a cosmic scale, such as the expansion of our part of the universe (with a preponderance of particles and not antiparticles) may be connected with the properties of elementary particles. Thus, the well known ratio of the neutron and electron masses suggests the existence of a universal mass ($m_0 = 1.25 \times 10^{-25}$ g) which, together with the constants c and h, form a complete set of fundamental constants with independent dimensionalities, leading to the concept of a mass ($m_G = 4 \times 10^{-66}$ g) associated with gravitational interaction. The characteristic time corresponding to the latter mass is

$H_0 = 3.6 \times 10^{-18}$ sec and is practically equal to the experimental value of the Hubble constant, 2.5×10^{-18} sec. The relation between the H_0 and the Hubble constant also follows from the empty-space Einstein equation with cosmological constant. Because of the extreme importance of the problem, these curious relations between atomic and cosmological quantities should evidently be taken seriously. (ATD)

14228 A STUDY OF THE DISTRIBUTION OF ATOMIC HYDROGEN IN THE ANDROMEDA NEBULA BY MEANS OF AN INTERFERENCE SPECTROMETER. Percy Edward Argyle. Thesis, Vancouver, Can., Univ. of British Columbia, 1964. 181p.

The increasing importance of narrow-band radiations is traced in the recent history of radio astronomy. The need for multi-channel spectrometers to observe these radiations is stressed. The theoretical basis of spectral analysis is given with particular emphasis on autocorrelation or interference methods. A twenty-channel radiofrequency spectrometer designed on interference principles was constructed and found to perform in accordance with its theory of operation. A large area including the position of the spiral galaxy M31 was surveyed with the help of the spectrometer. One hundred and forty-three independent spectra of the 21-cm radiation of atomic hydrogen were obtained and are analyzed in terms of area, velocity, and shape. The major axis of the nebula is found to extend about 2.5 either side of the center. The length of the minor axis, after correction for the effect of the antenna beamwidth, is only 40′. The position angle of M31, as revealed by the spectrometer observations, is distinctly less than the 38° established optically. A new value of 33° is proposed and it is suggested that the former value can be accounted for in terms of an increased axial ratio and the observed asymmetries in the light distribution. The velocity of the center of gravity of M31 was obtained by summation of all 143 spectra. The result was -295.6 ± 0.4 Km/sec with respect to the local standard of rest. Radial motions of a few Km/sec are possible in the outer parts of M31 but their presence has not been established. Many of the spectra have multiple peaks, which may be interpreted in terms of spiral structure. The velocities of certain concentrations of atomic hydrogen are measurable but their positions are not resolved by the antenna beam. (Dissertation Abstr., 25: No. 4, Oct. 1964)

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Refer also to abstracts 13383, 14064, 14065, and 14143.

14229 (AD-607917) SOLID-STATE AND MOLECULAR THEORY GROUP QUARTERLY PROGRESS REPORT NUMBER 54. (Massachusetts Inst. of Tech., Cambridge). Oct. 15, 1964. Contract Nonr-1841(34). 91p. $3.00(OTS).

The radii of maximum radial charge density of all the atoms are calculated by a relativistic self-consistent method involving the exchange correction derived from a free-electron model. These radii are compared with the empirical radii. The agreement is good and indicates some connection between interatomic distances and the sizes of the wave functions. The deviation between a properly chosen muffin-tin potential and a more realistic potential within a potassium chloride crystal is analyzed by the Fourier series. This deviation is included in the secular equation for the augmented plane wave method to see how much effect it would have on the actual energy bands. The effect is smaller than other inherent errors in energy band calculations. A potential which is spherically symmetrical within the atomic spheres, constant outside, can give a model capable of yielding satisfactory energy bands, provided the discontinuity of potential at the surfaces of the spheres is properly chosen. It is shown that it is possible to get a very satisfying picture of the energy bands of silver bromide and chloride crystals by the augmented plane wave method, and the calculations of DeCicco, though results on potassium chloride suggest that the modifications produced by a more realistic potential would be small. The effect of impurities in an alkali halide on the vibrational spectrum is analyzed. A method is presented for obtaining the contribution of impurity scattering to the thermal conductivity. Two models for the lattice vibrations of ionic crystals are discussed. A simple quantum mechanical derivation of the contribution of the impurities to the optical absorption is presented. Calculations and results made using the mass-defect approximation for NaI: Li^+ and NaI: K^+ are presented and discussed. (N.W.R.)

14230 (AD-608160) RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM. Seventh Quarterly Progress Report, June 16, 1964–September 15, 1964. R. Novick (Columbia Univ., New York). Sept. 15, 1964. Contract DA-36-039 SC 90789. 84p. $3.00(OTS).

Photon echoes were observed in ruby. In its simplest terms, the photon echo is that burst of radiation emanating from a crystal which was excited by intense, coherent light pulses at times τ and 2τ before the echo was formed. The purpose of the first excitation pulse is to excite in the crystal a superradiant state which quickly dephases because of inhomogeneous broadening. The dephasing continues until the second pulse arrives (τ seconds after the first pulse) and is then adjusted so that the populations of the upper and lower levels of the resonant transition are interchanged, thereby reversing the dephasing process. At a time τ after the second pulse the system will have rephased, and a superradiant state with a large oscillating electric dipole moment will be formed. The system will then radiate very strongly. This later burst of radiation which is now observed is called the photon echo. The discovery of the photon echo is a most exciting and important development, opening a new field of physics which will be actively pursued. An experimental program in x-ray astronomy was initiated. The immediate goal of this work is the determination of the polarization of the recently discovered discrete x-ray sources. The method of level-crossing spectroscopy was extended to the observation of the Stark effect. A precise measurement of the Stark shift of the 3P term of lithium was completed. Additional metastable autoionizing atomic states were observed in sodium and cesium. A systematic investigation of the Zeeman quenching of these states in all of the alkali elements was carried out using a new electron multiplier detector arrangement. A series of experiments were done to verify the predictions of Hartmann and Anderson on the effect of r-f irradiation on an NMR line shape. Results so far obtained are in agreement and thus give additional experimental evidence to the hypothesis that a spin system can be described by a temperature in the rotating frame while an r-f magnetic field is being applied. (auth)

14231 (AFCRL-63-709) CHARGE TRANSFER STUDIES WITH A TIME-OF-FLIGHT MASS SPECTROMETER–CROSS SECTION FOR N_2^+ ON N_2 AT 2650 ELECTRON VOLTS. W. W. Hunt, Jr., A. J. Stinnett, and R. Novack (Air Force Research Labs., Laurence G. Hanscom Field, Bedford, Mass.). Sept. 1963. 9p. (AD-422864). $1.60 (OTS).

A method of using the drift tube of an adapted time-of-flight mass spectrometer as the collision chamber for measuring charge transfer cross sections is described in detail. As a test of this method, the process $N_2^+ + N_2 \rightarrow N_2 + N_2^+$ was investigated at an N_2^+ energy of 2650 ev (laboratory system). From the data obtained, the cross section for this process was determined to be $\sigma = 1/\alpha\ (2.96 \pm 0.20) \times 10^{-15}$ cm², where α is an unknown pressure gauge sensitivity factor and the uncertainty refers to random errors only. (auth)

14232 (AFCRL-64-148) ANGULAR DEPENDENCE OF DIFFERENTIAL CROSS SECTION FOR CHARGE TRANSFER IN He^+ ON He COLLISIONS. Final Report. Edgar Everhart (Connecticut. Univ., Storrs). Apr. 30, 1964. Contract AF19(628)-2387. 16p. (AD-605594). $2.00(cy), 1(mn) CFSTI.

Differential measurements were made for the process He(+) + He yields He + He(+). The differential cross section for this charge transfer was determined at 12, 6, 3,

1.5, 0.75, and 0.44 kev. This quantity, in square centimeters, is plotted vs laboratory scattering angle in the range of 1 to 4 degrees. To obtain these results, the experimentally-measured electron capture probability was multiplied by a calculated value of the differential cross section for scattering of the fast particle. The interatomic potential energy function used in these calculations is one which was found experimentally to be in agreement with resonant electron capture data. (auth)

14233 (ARL-63-230) THE FIRST-ORDER DENSITY MATRIX FOR A SPIN-PROJECTED SINGLE DETERMINANT. II. NATURAL EXPANSION. John E. Harriman (Uppsala Univ.). Aug. 15, 1963. Contract AF61(052)-351. 27p. (AD-424772; TN-104). $2.60(OTS).

The first order density matrix is obtained for the state corresponding to a spin projection of general different orbitals for different spins single determinental function. Explicit expressions are given for the natural orbitals and occupation numbers in terms of parameters characteristic of the unprojected state. The spin density and the charge density matrices are found to have the same natural orbitals in the projected state as in the unprojected state. A number of special and limiting cases are considered, including that of slightly different orbitals for different spins. (auth)

14234 (IS-965) ORIGIN IMAGE SEEKER, AN IMAGE SEEKING PROGRAM FOR PATTERSON PROJECTIONS AND HARKER SECTIONS. D. A. Hansen and D. H. Erbeck (Ames Lab., Ames, Iowa). July 1964. Contract W-7405-eng-82. 27p. Dep.; $2.00(cy), 1(mn) OTS.

Origin Image Seeker is a program for the IBM-7074. It is written in Fortran, although the program uses an Autocoder subroutine. This program determines trial structures from Patterson projections and Harker sections provided that the projection contains either a real or projected atom at the origin or that the section contains a real atom at the origin. (auth)

14235 (LA-DC-6516(Rev.)) NUCLEAR MAGNETIC SHIELDING OF A HYDROGEN ATOM IN THE FIELD OF AN ELECTRIC DIPOLE. Edwin M. Roberts (Los Alamos Scientific Lab., N. Mex.). [196?]. Contract W-7405-eng-36. 28p. (CONF-641111-1). Dep.(mn); $2.00(cy), 1(mn) OTS.

From US-Japan Information Exchange Meeting on Ceramic Nuclear Fuels 19th High Temperature Fuels Committee Meeting, Canoga Park, Calif.

The wave function for a hydrogen atom in the field of an electric dipole is found to first order in perturbation theory. The potential function of the dipole is expanded in multipole form about the proton. The proton and dipole are assumed to be held in a fixed configuration. The effect of the dipole on the electron is assumed to be effectively given by the potential interior to a sphere whose surface passes through the point dipole and whose center is at the proton. The first-order correction to the wave function is in the form of an infinite series. The magnetic shielding factor is calculated. The anisotropic shielding factor contains a part linear in the dipole strength, p; it may be positive or negative depending on the configuration of the atom-dipole pair. The term linear in p is due to the part of the dipolar potential proportional to P_2 (μ). The isotropic shielding factor, $\bar{\sigma}$, contains a part quadratic in p but not a part linear in p. The diamagnetic and paramagnetic contributions to σ, both of which are negative, are calculated separately. The paramagnetic contribution is calculated with somewhat more accuracy than the diamagnetic contribution. Numerical results are given and discussed. (auth)

14236 (ORNL-tr-467) ION REFLECTION AND SECONDARY ELECTRON EMISSION DURING IMPACT OF ALKALI IONS ON PURE MOLYBDENUM SURFACES. Curt Brunnee. Translated for Oak Ridge National Lab., Tenn., from Z. Physik, 147: 161-83(1957). 32p. Dep.(mn); $3.60(fs), $1.16(mf) JCL.

In order to obtain information on the interaction of ions in the intermediate energy region (0.4 to 4 kev) with a metal lattice, the ion reflection and secondary electron emission during impact of alkali ions on a pure Mo surface is determined experimentally with a 60° mass spectrometer. The most important results of the measurement of ion reflection are the reflection factor ρ is approximately independent of energy in the energy range of 1.5-4 kev, ρ depends essentially only upon the mass ratio of the ions and target atoms and decreases with an increasing ion mass in the sequence of Li to Cs, the mean energy of the reflected ions decreases in the sequence of Li to Cs. These experimental findings resulted in the assumption of ion reflection by isotropic multiple back-scattering, whereby lattice collisions can be approximately considered as collisions between free rigidly elastic spheres. The most important results of the SE (secondary electron emission) measurements are the SE-factor γ increases approximately linearly with the energy from a threshold value, γ decreases with increasing mass and increasing ionization work of the ion with a fixed primary energy, and the energy distribution of SE has a distinct maximum near 0 ev and has decreased already to about 1% at 10 ev. The mean energy of the SE triggered by various alkali ions decreases in the sequence of Li to Cs. These test results can be interpreted qualitatively if we assume that the ions in the metal produce SE by ionization processes corresponding to their energy and directional distribution. The energy and direction distribution of the ions, as shown by the results of the reflection factor determinations, are determined by the lattice collisions and the influence of ionization on the distribution can be neglected. (auth)

14237 EMPIRICAL CORRELATIONS BETWEEN THE ATOMIC STRUCTURE AND SOME PHYSICAL CONSTANTS OF THE ELEMENTS. J. Benkoe. Acta Chim. Acad. Sci. Hung., 41: 401-11(1964). (In German)

In several groups of the elements, some correlations can be derived between the melting points and densities. These correlations are also related to the atomic numbers and to the electron configuration of the elements. The quotient of the heat of melting and of the melting points affords characteristic data in respect to the metals, transition elements, and to the halides. In the majority of elements, a certain periodicity was found to exist in the ratio of the boiling points to the melting points. (auth)

14238 ISOTOPIC SHIFT AND CONFIGURATION MIXTURE IN THE I-SPECTRUM OF COPPER. M. Elbel and W. Fischer (Universität, Marburg, Ger.). Ann. Physik (7), 14: 78-90(1964). (In German)

The isotopic shifts of the ultraviolet transitions between the $3d^94s^2-3d^94s4p$, $3d^94s^2-3d^{10}np$, and $3d^{10}4s-3d^94s4p$ configurations in the I-spectrum of copper were determined with the aid of interference-spectroscopic techniques by employing electromagnetically separated isotopes. The coupling effects of the terms involved were derived from the isotopic shifts thus determined. The results obtained were discussed. (OTS)

14239 LASER ACTION IN URANYL-SENSITIZED Nd-DOPED GLASS. N. T. Melamed, C. Hirayama, and P. W. French (Westinghouse Electric Corp., Pittsburgh). Appl. Phys. Letters, 6: 43-5(Feb. 1, 1965).

Laser action was observed in a rod of barium crown glass containing Nd^{3+} sensitized by uranyl ions. Pumping was provided by a xenon flash lamp. The glass produces giant spikes without the use of external Q spoilers through an intrinsic Q-switching mechanism, due to the behavior of the uranyl ion as a saturable filter. Evidence for energy transfer from UO_2^{2+} to Nd^{3+} by a resonance process was also obtained. (D.C.W.)

14240 Yb^{3+}-Er^{3+} GLASS LASER. E. Snitzer and R. Woodcock (American Optical Co., Southbridge, Mass.). Appl. Phys. Letters, 6: 45-6(Feb. 1, 1965).

By energy transfer from Yb^{3+} to Er^{3+} in a silicate glass, Er^{3+} was made to emit laser oscillations at 1.5426 μ as a three-level laser at room temperature. The lifetime for fluorescence of Er^{3+} from the $^4I_{13/2}$ level was measured to be 14 msec at room temperature. (D.C.W.)

14241 ENERGY TRANSFER IN TRIPLY ACTIVATED GLASSES. H. W. Gandy, R. J. Ginther, and J. F. Weller (Naval Research Lab., Washington, D. C.). Appl. Phys. Letters, 6: 46-9(Feb. 1, 1965).

Evidence for energy transfer from Ce^{3+} and Nd^{3+} to Yb^{3+} in a Li-Al-Mg-SiO_2 glass and from UO_2^{3+} and Nd^{3+} to Yb^{3+} in barium crown glass was observed. Yb^{3+} was the final emitting ion in both cases. In the latter case, a double radiationless transfer of energy from UO_2^{3+} to Yb^{3+} occurs with high efficiency under the necessary condition that Nd^{3+} serve as the bridging ion in the sequential radiationless transfer process. (D.C.W.)

14242 CALCULATIONS OF INTENSITIES OF EMISSION OF CHARACTERISTIC X-RADIATION. S. G. Tomlin (Univ. of Adelaide). Australian J. Phys., 17: 452-61(Dec. 1964).

Intensities of emission of characteristic x radiation from thick targets of silver, copper, chromium, aluminum, carbon, boron, and beryllium were calculated using the theory of Metchnik and Tomlin, and the results were compared with experimental data. The effect of the backscattering of electrons from the target was examined in detail, and the correcting factor k, which allows for this and for the effects of fluorescence yield and indirect excitation by the white radiation was tabulated. (auth)

14243 EQUILIBRIUM FRACTIONS FOR A HYDROGEN-ION BEAM (10-50 kev) IN 17 GASES AND VAPORS. A. B. Wittkower, R. P. Bastide, N. B. Brooks, P. H. Rose, and L. Hopwood (High Voltage Engineering Corp., Burlington, Mass.). Can. J. Phys., 43: 96-101(Jan. 1965).

The equilibrium fractions for a hydrogen-ion beam were measured, from 10 to 50 kev, in the following gases or vapors: hydrogen, helium, nitrogen, oxygen, neon, argon, krypton, xenon, nitrous oxide, deuterium, water vapor, ammonia, methane, sulfur hexafluoride, butane, 2,2-dimethylpropane, and carbon dioxide. (auth)

14244 IMPROVED ATOMIC PHYSICS CALCULATIONS. W. R. Conkie (Queen's Univ., Kingston, Ont.). Can. J. Phys., 43: 102-10(Jan. 1965).

A method is developed for calculating the energy of a definite state of an N-electron system. The method uses a form of the Bethe-Goldstone equation to calculate the correlation energy of an interacting electron pair moving in the nuclear Coulomb field and in the average field of the other electrons. A calculation on the ground state of the lithium atom gives an energy which differs from the accurate value by less than 0.1%. (auth)

14245 VALENCE FORCE CONSTANTS OF MoF_6, TcF_6, AND ReF_6. Ran B. Singh and D. K. Rai (Banaras Hindu Univ., Varanasi, India). Can. J. Phys., 43: 167-9(Jan. 1965).

The results of calculations for the valence force constants of MoF_6, TcF_6, and ReF_6 are presented. (C.E.S.)

14246 THE GENERALIZATION OF THE SCHROEDINGER EQUATION IN THE CASE OF THE HYDROGEN ATOM. Assene Datzeff (Univ. of Sofia). Compt. Rend., 259: 3963-6(Nov. 30, 1964). (In French)

A generalization of the Schroedinger equation established previously for non-bound particles of the same species and with high density is extended to the case of hydrogen. (tr-auth)

14247 THE BROADENING OF THE LINES OF HYDROGEN. Henri Van Regemorter (Observatoire de Paris-Meudon). Compt. Rend., 259: 3979-82(Nov. 30, 1964). (In French)

It is shown that in the calculation of the contribution of the electrons to the width of the higher lines of hydrogen, the Stark sub-levels can not be assumed to remain degenerate. It is shown that the intervening impact parameters are much smaller than the Debye radius. Consequently, the impact approximation can not be applied to these lines, in agreement with the experimental results of Ferguson, Schlueter and Vidal. (D.C.W.)

14248 CAPTURE OF ANTIPROTONS BY ATOMIC SHELLS WITH EMISSION OF ATOMIC ELECTRON. Yu. D. Fiveiskii (Inst. of Engineering Physics, Moscow). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 6-10(1964). (In Russian)

An account is presented of the theory of the Auger effect for incident antiprotons with nonrelativistic energies for the case of both light and medium atoms. It is found that in the investigated antiproton energy range the Auger effect is caused basically by the emission of K electrons. It is shown that for low antiproton energies capture of the latter proceeds mainly for the condition that $n \lesssim M/m$ and $l \lesssim n$. (tr-auth)

14249 CONSTANT ENERGY AND MINIMUM ENERGY ORTHOGONALIZATION. Hubert W. Joy (Oak Ridge National Lab., Tenn.), L. J. Schaad, and George S. Handler. J. Chem. Phys., 41: 2026-31(Oct. 1, 1964).

The problem of orthogonalizing a set of orbitals is considered, noting that the energy calculated for a determinantal wavefunction is often changed by such a procedure. Rules are given for finding whether a particular determinantal wavefunction will, in fact, yield different results on orthogonalization of its basis set. A new orthogonalization procedure, minimum energy orthogonalization, is illustrated, and some of its possible uses are examined. (auth)

14250 PRODUCTION OF FREE RADICALS IN ORGANIC SOLIDS BY HYDROGEN-ATOM BOMBARDMENT. T. Cole and H. C. Heller (Ford Motor Co., Dearborn, Mich). J. Chem. Phys., 42: 1668-75(Mar. 1, 1965).

A beam of hydrogen (or deuterium) atoms, produced by a microwave electrodeless discharge, was found capable of producing free radicals upon striking polycrystalline samples of malonic acid, malonamide, methyl malonic acid, and methyl malonamide. The radicals produced in these compounds, identified by means of their electron magnetic resonance signals, arose from the removal of a methylene hydrogen of the parent molecule. Only one radical species was produced in each compound, in contrast to x irradiation, which often produced several types of radicals. The study suggested that the impinging hydrogen atoms abstract methylene hydrogens from the organic molecules to form radicals and H_2 and penetrate several molecular layers of the crystallites before they react. Radicals were also formed by impinging hydrogen atoms in naphthalene, hexamethylene tetramine, calcium malonate, calcium formate, and aluminum acetyl acetonate. However, no positive identification of these radicals could be made on the basis of their powder EMR spectra. On the other hand, several other organic powders gave no radicals by the hydrogen-bombardment technique. (auth)

14251 ON THE ORIGIN OF SPIN-HAMILTONIAN PARAMETERS. R. McWeeny (Univ. of Keele, Staffordshire, Eng.). J. Chem. Phys., 42: 1717-25(Mar. 1, 1965).

The various coupling constants which appear in the phenomenological spin Hamiltonian for an atom or molecule can, in principle, be determined from a knowledge of the electronic wavefunction. It is difficult to obtain a physical picture of their origin and interrelationship because of the complexity of the many electron wavefunction. The problem may be greatly simplified by introducing certain standard density functions, of which the "spin density" is the most familiar. Only three types of function are required, all with a physical meaning that is readily visualized. Their significance in determining spin-Hamiltonian parameters is discussed and illustrated with reference to hyperfine coupling (contact and dipole–dipole), nuclear spin–spin coupling, electron spin–spin coupling, and g values. (auth)

14252 PERTURBATION THEORY AND THE VIRIAL THEOREM. H. Preuss (Max-Planck-Institut für Physik und Astrophysik, Munich) and H.-H. Schmidtke. J. Chem. Phys., 42: 1847(Mar. 1, 1965).

For atomic problems a formula was derived by a scaling process which takes into account the virial theorem in perturbation calculations. In the equation $E = E_0 + \langle\mu\rangle + \langle\mu\rangle^2/4E_0$), E_0 represents the energy of an atom in the ground state when electron interaction is neglected. This interaction is then taken as a perturbation, where $\langle\mu\rangle$ is the first-order perturbation energy. A corresponding formula was worked out for molecules. (M.C.G.)

14253 TWO-PHOTON IONIZATION OF ATOMIC HYDROGEN. PART II. W. Zernik and R. W. Klopfenstein (RCA Labs., Princeton, N. J.). J. Math. Phys. (N. Y.), 6: 262-70(Feb. 1965).

A general formula is given for the total cross section for two-photon ionization of a hydrogenic state. An implicit method for evaluating the second-order radial matrix elements that occur in this expression is described in detail. Numerical results were obtained for the states with principal quantum numbers n = 1 through 5. It is concluded that, when both one- and two-photon ionization are energetically possible, the effect of the latter may be expressed as an intensity-dependent correction to the Gaunt factor which may therefore be written as $G = g_1 + \zeta I \lambda^3 g_2$. Here g_1 is the usual Gaunt factor, I is the intensity of the light in W cm^{-2}, λ is the wavelength in cm, g_2 is a dimensionless factor of order unity, and ζ is a constant given by $\zeta = 0.1504$ W^{-1} cm^{-1}. Graphs of g_2 are given as a function of electron energy. These results do not include the effect of three-photon processes, which can also contribute to the first-order intensity-dependent correction to the Gaunt factor as a result of interference between the first- and third-order amplitudes. (auth)

14254 ON PLANETARY ELECTRON CORRECTIONS TO ELECTRON DIFFRACTION INTENSITY DATA. T. Iijima and R. A. Bonham (Indiana Univ., Bloomington). J. Phys. Chem., 68: 3146-9(Nov. 1964).

A new technique for correcting electron diffraction intensity data for planetary electron scattering from molecules in the gas phase is presented. The procedure does not make any assumptions about the molecular structure but still guarantees that the radial distribution will remain positive. Corrections to the peak areas in the resulting radial distribution function are discussed, and the possible application of the technique to the analysis of x-ray scattering data from liquids is pointed out. (auth)

14255 ASYMMETRY OF THE LYMAN-ALPHA LINE PROFILE OF ATOMIC HYDROGEN. Nguyen-Hoe, H.-W. Drawin, and L. Herman (Laboratoire de Recherche Physique, Paris). J. Quant. Spectry. Radiative Transfer, 4: 847-56(Nov.-Dec. 1964). (In French)

The profile of a Stark broadened Lyman-α line was calculated for three different ion densities. Linear and quadratic Stark effect were taken into account for the Stark components. The perturbing ion field was treated as an intermolecular ion field having a dipole and a quadrupole component. The calculations showed that the intensity of the "red" wing increases and that of the "blue" wing decreases under the influence of the quadrupole component of the ion field, whereas the quadratic Stark effect and the variation of the intensities of the Stark components under the influence of the dipole component of the field gave an increase of the "blue" and a decrease of the "red" wing. The sum of all these effects finally gave an asymmetric line profile showing the intensity of the "red" side to be slightly greater than that of the "blue" one, in qualitative agreement with experimental results. (auth)

14256 TABLES OF ELECTRON DENSITY AS A FUNCTION OF THE HALFWIDTH OF STARK-BROADENED HYDROGEN LINES. R. A. Hill (Sandia Lab., Albuquerque, N. Mex). J. Quant. Spectry. Radiative Transfer, 4: 857-61(Nov.-Dec. 1964).

Tables of electron density as a function of the halfwidth of Stark broadened Ly-α, Ly-β, Hα, Hβ, Hγ, and Hδ emission lines were prepared by interpolating the tables of S(α) of Griem, Kolb, and Shen. Graphs constructed from these tables provide a rapid means of estimating electron densities from experimentally obtained line profiles. (auth)

14257 ISOTOPE EFFECT ON FRAGMENTATION AND KINETIC ENERGY OF FRAGMENT IONS FROM CARBON DIOXIDE PRODUCED BY ELECTRON IMPACT. Miyako Inoue, Tsutomu Watanabe, and Akibumi Danno (Japan Atomic Energy Research Inst., Tokyo). Japan. J. Appl. Phys., 3: 761-6(Dec. 1964).

To clarify the discrepancy between the values of the isotope effect on C^+ ion formation obtained by using magnetic-field scanning and electric-field scanning type mass spectrometers, the errors resulting from the electric field scanning are estimated. Isotope effect on the formation of the C^+ ions from carbon dioxide produced by electron impact is measured as a function of electron impact voltage. The effect on the C^+ ion yield, defined as the ratio $[(^{13}C^+)/(^{12}C^+)]/[(^{13}CO_2^+)/(^{12}CO_2^+)]$ where the parenthesis means the peak height of each ion, is determined as 1.008 ± 0.0015 at 70 v of electron impact voltage. The kinetic energy of the C^+ ions is measured by the discrimination method and is about 0.9 ev. Based on the results of isotope effect and kinetic energy measurements, the dissociation processes from the parent ion to C^+ ion are discussed. (auth)

14258 EXCITATION OF Al $L_{II\text{-}III}$ LEVELS BY 50 kv ELECTRONS. Hiroshi Watanabe (Hitachi Central Research Lab., Tokyo). Japan. J. Appl. Phys., 3: 804-5(Dec. 1964).

The excitation of Al $L_{II\text{-}III}$ levels is studied by making use of a high resolution energy analyzer, and the peaks in the energy spectrum are compared with the fine structure of the Al L-absorption edge of x rays. The 72-ev peak of Al corresponds to the $L_{II\text{-}III}$ absorption edge, and the other peaks may correspond to fine structures in the high energy side of the edge. The $L_{II\text{-}III}$ peak in pure Al shifts and splits into 77 and 79-ev peaks in Al_2O_3. This shift shows that the $L_{II\text{-}III}$ binding energy is 5 to 7 ev larger in the Al^{3+} state than in the zero valence state of the atom. (C.E.S.)

14259 INVESTIGATION ON THE FINE STRUCTURE OF THE 2-7. BALMER LINES IN DEUTERIUM. Laszlo Csillag. Magy. Tud. Akad. Kozp. Fiz. Kut. Inst. Kozlemen., 12: 453-9(1964). (In Hungarian)

The fine structure of the 2-7 Balmer lines in gaseous deuterium was studied. The experimental apparatus is described. A high frequency discharge tube in which deuterium at 0.025 torr was circulated served as light source. Resolution of the lines is achieved by crossing a quartz Fabry-Perot interferometer with a spectrograph. (auth)

14260 SOME REMARKS ON THE INVESTIGATION OF NEUTRON MAGNON SCATTERING. Adam Wanic (Inst. of Nuclear Physics, Krakow). Nukleonika, 9: 839-46(1964).

The construction of an ideal scattering surface by the mathematical solution of conservation equations with the quadratic approximation of the dispersion relation is described. The method was applied to a neutron lattice and a magnon lattice shown in the case of a pyrrhotite Fe_7S_8 crystal. Next, the scattering pattern was obtained under real conditions by using a monochromator and an analyzer. The movements of the monochromator spot, the analyzer spot, and the tau-vector should be correctly combined. Also the presence of a constant energy gap should be considered. Resulting expressions and diagrams are illustrated. (ATD)

14261 FACTORS CONTROLLING THE PRODUCTION OF FISSION-FRAGMENT TRACKS IN THIN METAL FILMS. J. J. Kelsch, A. N. Goland, and Arthur Paskin (Brookhaven National Lab., Upton, N. Y.). Phys. Chem. Solids, 26: 203-7(Jan. 1965). (BNL-8077)

The results of a quantitative investigation of the role of resistivity and film thickness in track production are reported. Using thin evaporated palladium films it was demonstrated that films whose resistivity approaches bulk values do not show evaporation tracks, and that those whose resistivities are in excess of ten times bulk value do show such tracks. It was further demonstrated that tracks are not produced in films whose thickness is much in excess of the crystallite dimensions, even when the resistivity is high. (P.C.H.)

14262 THEORY OF SINGLE CRYSTAL SPUTTERING. Yu. V. Martynenko. Soviet Phys.-Solid State (English Transl.), 6: 1581-5(Jan. 1965). Translated from Fiz. Tverd. Tela, 6: 2003-9(July 1964).

A formula containing no empirical coefficients is obtained for the sputtering coefficient of a single crystal. It is assumed that the interaction potential of the ions with the atoms of the target is $U = A/r^2$. It is shown that the screening of the lower atomic layers by the overlying ones

should result from such a potential, as is necessary to explain the dependence of the sputtering coefficient on the angle of incidence of the ions. The average energy lost by an ion in each atomic layer is calculated. To obtain a numerical value of the sputtering coefficient it is assumed that the transmission of energy to the surface occurs by means of focusons. Face-centered cubic crystals are investigated, and only focusons in the [110] directions are considered. The calculated curves for the sputtering coefficient as a function of the angle of incidence of the ions are compared with experiment. (auth)

14263 MEASUREMENT OF THE CHARACTERISTIC PRESSURE DISTRIBUTION OF SOME He(I) AND Ar(I) LINES. U. Pittack (Universität, Kiel). Z. Astrophys., 60: 190-8(1964). (In German)

He(I) and Ar(I) were excited at gas pressures of 1 to 3 atm by electron collisions. Because of the low electron density and the low gas temperature, the broadening by the Stark effect and the Doppler effect can be neglected so that the effect of the self-pressure broadening of the same type of particle can be measured. The line widths measured were compared with the Furssow and Wlassow theory. (tr-auth)

14264 ON THE THRESHOLD POTENTIAL AND IONIZATION YIELD IN COLLISIONS OF UNCHARGED PARTICLES. H. Fetz and H. Bussmann (Universitat, Wurzburg, Ger.). Z. Naturforsch., 19a: 1475-7(Dec. 15, 1964). (In German)

With a beam of neutral particles (inert gas atoms and molecules of H_2 and N_2), produced by charge-exchange, the ionization efficiency up to energies of 300 ev and the threshold in collisions with particles of the same kind were investigated. The threshold, determined by extrapolating the experimental curves, is (in good agreement with the impact conservation laws) twice the ionization energy. The rise of ionization with energy (up to 100 ev) can be expressed by a power-function with a mass dependent exponent between two and three. There was no indication that the ionization goes through a maximum in the lower energy range. (auth)

14265 MOLECULAR BEAM MEASUREMENTS OF SCATTERING CROSS SECTIONS FOR TRANSITIONS BETWEEN REFINED ROTATIONAL STATES OF TWO-ATOM MOLECULES. I. EXPERIMENTAL METHODS. J. P. Toennies (Universität, Bonn). Z. Physik, 182: 257-77 (1965). (In German)

Inelastic collision cross sections for transitions between specified rotational states designated by (J,M) were measured in a molecular beam apparatus. With an electrostatic four pole field molecules in a specified rotational state are separated out of a molecular beam and focussed into a gas filled scattering chamber. Molecules which have been scattered by less than $\frac{1}{2}°$ are then collected in a second four pole field, located directly behind the scattering chamber, and are analyzed for their rotational state. From a comparison of the measured pressure dependence with calculated curves a determination of inelastic collision cross sections for specified quantum jumps is possible. Measured inelastic scattering cross sections for the transitions (2,0 → 3,0) are reported for the gases He, Ne, Ar, Kr, CH_4, SF_6, H_2, O_2, Air, N_2O, H_2O, CF_2Cl_2. The values range between about 5 and 100 $Å^2$ in the order indicated. The scattering gases NH_3 and ND_3 yielded larger cross sections of about 600 $Å^2$ and, in addition, the transitions (3,0) → (2,0), (1,0) → (2,0), (2,0) → (1,0) and (3,0) → (1,0) were observed. Total cross sections for the same gases were also measured with the apparatus. (auth)

14266 ELECTRON AVALANCHES AT HIGH E/p. DETERMINATION OF THE DRIFT VELOCITIES OF ELECTRONS AND IONS, ELECTRON COLLISION IONIZATION AND ELECTRON ENERGIES. Hans Schlumbohm (Universität, Hamburg). Z. Physik, 182: 306-16(1965). (In German)

Current shapes of electron avalanches are calculated for low-pressure and high-E/p uniform electric field conditions. It is shown that drift velocities of electrons and positive ions and the ionisation-coefficient α for electrons can be obtained from low to high E/p-values of over several 10^3 v/cm torr by analysing the current pulses which are measured using fast oscilloscopic techniques. Moreover, values of the diffusion energy (diffusion coefficient over mobility) of the electrons can be determined from the diffusion-broadening of the current shapes. — Values of the diffusion energy are given for methane ranging from kT ≅ 4 to 15 ev corresponding to E/p ≅ 40 to 2000 v/cm torr. (auth)

14267 OBSERVATIONS ON DETERMINATION OF THE VAN DER WAALS CONSTANTS FROM SCATTERING CROSS SECTIONS. H. G. Bennewitz and H. D. Dohmann (Universitat, Bonn). Z. Physik, 182: 524-7(1965). (In German)

The attempt was made previously to clear up the discrepancy between van der Waals constants determined from scattering cross sections for thermal energies and theoretical values using measured oscillator strengths. Three sources of error not accounted for properly in the earlier work are discussed. The appropriate corrections discussed lead to a satisfactory agreement between experiment and theory. (auth)

14268 TIME-RESOLVED SPECTROSCOPIC INVESTIGATION OF THE 2nd POSITIVE SYSTEM OF N_2 EMITTED FROM A GLOW DISCHARGE. H. Dunken, W. Mikkeleit, and S. Rentsch (Universität, Jena, Ger.). Z. Physik. Chem. (Frankfurt), 42: 314-21(Sept. 1964). (In German)

The emission of the $C^3\Pi - B^3\Pi$ electron band system of N_2 (2nd positive system) in a pulse glow discharge was followed during the burning period of each pulse in its time decay. The release of the discharge and the time point of the beginning of the band emission were rigidly periodic. The arrangement of a rotating slit tumbler facilitated both control of the discharge and fixing the time point of the photography. The smallest resolvable time interval was 66 μsec. The glow discharge was ignited with 2 kv and burned about 500 μsec. The emission pattern during this time was followed on the basis of density measurements on the band edges of the 2nd positive system. It was observed that each vibration band passed through an intensity maximum characteristic for it. The explanation of this behavior was studied. (tr-auth)

14269 X-RAY SMALL ANGLE SCATTERING ON FILAMENT MOLECULES. I. DEPENDENCE OF THE ELECTRON DENSITY DISTRIBUTION ON FILAMENT CROSS SECTION. R. G. Kirste (Universität, Mainz). Z. Physik. Chem. (Frankfurt), 42: 351-7(Sept. 1964). (In German)

The cross section factor of the scattering curves of filament molecules depends strongly on the electron density distribution in the filament cross section and on the electron density of the solvent. An elimination of the uncertainties connected with this was possible by variation of the electron density of the solvent. (tr-auth)

14270 X-RAY SMALL ANGLE SCATTERING ON FILAMENT MOLECULES. II. CALCULATION OF THE SCATTERING CURVE OF HELICES. R. G. Kirste (Universität, Mainz). Z. Physik. Chem. (Frankfurt), 42: 358-66(Sept. 1964). (In German)

A method for the calculation of the scattering curves of helical macromolecules in solution is described. The numerical execution was undertaken for screw lines with various ratios of radius to identity period. (tr-auth)

14271 ON THE RESONANT ANNIHILATION OF POSITRONS IN COLLISIONS WITH NEUTRAL ATOMS AND MOLECULES. V. I. Gol'danskii and Yu. S. Sayasov (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1995-7(Nov. 1964). (In Russian)

A quantitative and qualitative interpretation is presented for the anomalous fast annihilation of positrons in polyatomic gases. The cause for this annihilation is found to be a positron-molecule bound state with a binding energy close to 1.0 ev. Since the positron slows down to such an energy within a time much shorter than the Dirac annihilation time, the positron is annihilated by the molecule as a whole in resonant fashion, with a probability much higher than

that of the Dirac annihilation. Formulas are presented for the cross section of this annihilation and for the existence of a resonant energy level. It is concluded that to check on this interpretation it would be necessary to observe elastic scattering of slow positrons (~0.1 ev) in those polyatomic gases in which increased annihilation rates are observed. (ATD)

14272 EXCITED O_2^+ AND N_2^+ ION PRODUCTION BY ELECTRON AIR IONIZATION. S. E. Kupriyanov. Zh. Eksperim. i Teor. Fiz., 47: 2001-3(Nov. 1964). (In Russian)

To determine the energy state of O_2^+ and N_2^+ ions produced when the oxygen and nitrogen molecules collide with electrons, the dissociation of O_2^+ and N_2^+ ions accelerated to 2.8 kev by single collisions with molecules was investigated. In view of the fact that earlier investigations were confined to atomic rather than molecular ions, a double mass spectrometer was used to measure the effect of electron energy on the dissociation cross section of the following processes: $O_2^+ + M \rightarrow O^+ + [O + M]^*$, $O_2^+ + M \rightarrow O^- + [O + M]$, and $N_2^+ + M \rightarrow N^+ + [N + M]$. The results are illustrated. The curves indicate that an increase in the electron energy greatly increases the cross sections of the processes, with the increase occurring in the electron energy region near the threshold of the excited electronic states of the ions O_2^+ and N_2^+. The results obtained for the first process agree with those obtained by J. W. McGowan and L. Kerwin (Can. J. Phys. 41: 316 (1963)) in the corresponding energy range. The behavior of the cross sections is shown briefly to be compatible with existing theoretical notions and experimental data. (ATD)

14273 THE STOPPING CROSS SECTIONS OF CARBON AND HYDROCARBON SOLIDS. Chester Arthur Sautter. Thesis, Lincoln, Neb., Univ. of Nebraska, 1964. 168p.

The stopping cross sections for protons and helium ions were measured in carbon, polypropylene, $(C_3H_6)_n$, and polyvinyltoluene, $(C_9H_{10})_n$, in the 30- to 350-kev energy range. The proton measurements of Lorents and Zimmerman on polyethylene, polystyrene, and a styrene-butadiene copolymer were repeated and refined for the energy interval of 170 to 350 kev. The standard deviations in the stopping cross sections obtained from smooth curves drawn through points of individual measurements vary between 1.7% and 4.3%. Where comparable, the stopping cross sections are in fairly good agreement with prior experimental work. The proton stopping cross section calculations of Brandt at New York University for higher energies extrapolate smoothly onto the present experimental curves. The invalidity of the Bragg rule of additivity for the energy-loss cross sections of solid hydrocarbons for protons below 150 kev was demonstrated. It was also demonstrated that the atomic stopping cross sections for protons in carbon obtained by subtraction of the hydrogen contribution to measured molecular cross sections are incorrect. If electron stopping cross sections obtained from the proposed additivity rule of Lorents and Zimmerman of the University of Nebraska are employed, the predicted proton stopping cross sections for carbon agree with the experimental results to better than 5%. Comparison of the helium ion and proton energy-loss cross sections of solids and gases revealed features that reflect either differences in the stopping characteristics of these two physical states, or effects of chemical binding that depend on the incident ion, or charge-exchange and charge-state effects, or a combination of these. The assumption that the helium ion to proton stopping cross section ratio (at the same velocity) is independent of the stopping material was clearly disproved. (Dissertation Abstr., 25: No. 4, Oct. 1964)

Cosmic Radiation

Refer also to abstracts 13863, 14420, 14432, and 14536.

14274 (NASA-CR-148) COSMIC RAY COLLISIONS IN SPACE. PART I. THE ENERGY SPECTRA OF ELECTRONS FROM PION-MUON-ELECTRON DECAYS IN INTERSTELLAR SPACE. Final Report. Joseph H. Scanlon and S. N. Milford (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Jan. 1965. Contract NASw-699. 174p. $5.00(OTS).

The energy spectra of electrons from charged pion decays in interstellar space have been determined. The predominant π-μ-e mode is considered. The analysis starts with the known distribution of electrons from muon decay in the muon rest frame. After Lorentz transformation to the pion rest frame, the muon distribution from pion decay is introduced. All directions are related to a fixed set of axes. The muon momentum and angular dependence is then integrated out. A second relativistic transformation yields the electron energy and angular distribution in the system in which the pion decays in flight. Integration over the electron direction then gives the energy spectra of the electrons. It is found that as a direct consequence of the relativistic transformation kinematics, the distribution function assumes a different mathematical form in four well-defined regions of pi meson energy. Within three of these pion ranges, four regions of electron energy must be separately considered; in the highest pion energy region, there are three electron energy regions. The normalization requirement yields a useful check on the distribution in the pion rest and moving frames. Numerical values of the spectra were computed on an IBM 7094 for twenty-six pion kinetic energy values from 3 Mev to about 110 Bev. The peak of the distribution is found to decrease monotonically from 0.31×10^{-1} Mev^{-1} at $\gamma_\pi = 1.02$ to 0.20×10^{-4} Mev^{-1} at $\gamma_\pi = 800$. The assumptions of isotropy and large pion lab energies have been avoided. Since the final expressions for the electron spectra are in closed form, they offer the possibility of analytical solutions in problems involving π-μ-e decay. (auth)

14275 (NASA-CR-149) COSMIC-RAY COLLISIONS IN SPACE. PART II. HIGH-ENERGY GAMMA RAYS FROM COSMIC-RAY COLLISIONS IN SPACE. Final Report. M. Lieber, S. N. Milford, and M. S. Spergel (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Jan. 1965. Contract NASw-699. 105p. $4.00(OTS).

A major source of very high energy cosmic gamma rays is the collision of high energy cosmic ray protons with intergalactic gas. High energy gamma rays are produced directly through the decay of neutral pions, which are present as secondaries in the collision. The relativistic hydrodynamic model, which visualizes the colliding high energy protons as fluids, is used to obtain the pion distributions in both energy and angle; these agree with available data. A source function for gamma rays of energy above 10 Bev is found by combining the pion production and decay spectra with the primary cosmic ray proton flux. The resulting gamma ray spectrum follows a different power law than spectra based upon the usual assumption of a line spectrum for the pions in the center of mass system of the colliding protons. The high-energy gamma intensity in space is calculated for a simple Euclidean expanding universe. By comparison with estimates for the proton photoproduction process, it is found that proton-proton and proton-photon collisions appear to contribute about the same order of magnitude to the intergalactic gamma ray intensity above $\sim 10^{15}$ ev. The calculated intensities are within the observed upper limits. (auth)

14276 (NP-14661) HIGH-ENERGY COSMIC GAMMA RADIATION. E. M. Hafner and G. Share (Rochester, N. Y. Univ.). [1964]. 69p.

A sequence of ten balloon-borne experiments was designed to detect gamma rays by conversion in lead. The counter telescopes were sensitive to radiation from directions near zenith; nominal acceptance cones of 10, 30, and 60° have been used. Seven of the flights produced useful data at high altitude, with results in three classes: an isotropic background flux of at least 6×10^{-4} γ/cm^2-sec-ster which may be of primary origin; an anomalous flux from 20 hr. right ascension and +30° declination, with an intensity of at least 2×10^{-4} γ/cm^2-sec; and several short time variations of gamma ray and charged particle fluxes. (auth)

14277 VELOCITY DEPENDENCE AND SOURCE SPECTRA OF SOLAR PROTON EVENTS. Frank B. McDonald (Goddard Space Flight Center, Greenbelt, Md.). Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser., 57: No. 8, Pt. A, 111-8(Aug. 1964).

Four modes of solar proton transport to the earth are described. It is then shown how the velocity dependence of one mode can be used to determine the energy spectrum of the particles at the time of release from the sun. (D.C.W.)

14278 DISCRETE SOURCES OF X RADIATION. V. L. Ginzburg and S. I. Syrovatskii (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 158: 808-10(Oct. 11, 1964). (In Russian)

Recently, x radiation of cosmic origin was detected. A formula was developed that expresses the magnetobremsstrahlung flux in a cosmic-ray source. Another formula represents the ratio of two fluxes from different parts of the emitting volume where the electron spectra differ and the difference is characterized by a coefficient. The size of the emitting volumetric part was determined with assumed numerical values for the electron energy and the intensity of the magnetic field. Strong magnetic fields may exist only in parts of collapsed stars as neutron stars. (TCO)

14279 RADIO PULSES FROM EXTENSIVE COSMIC-RAY AIR SHOWERS. J. V. Jelley (Atomic Energy Research Establishment, Harwell, Berks, Eng.), J. H. Fruin, N. A. Porter, T. C. Weekes, F. G. Smith, and R. A. Porter. Nature, 205: 327-8(Jan. 23, 1965).

Cosmic-ray showers in the energy region from 10^{15} to 10^{16} ev were detected with an array of three G-M counters operated in coincidence. The coincidence arrangement was operated in connection with an aerial array. It was concluded that short radio pulses of duration <0.25 μsec were observed from extensive air showers. (D.C.W.)

14280 OBSERVATIONS OF THE QUASI-STELLAR AND OTHER RADIO SOURCES WITH AN INTERFEROMETER OF RESOLVING POWER 0.4 SEC OF ARC. B. Anderson, W. Donaldson, H. P. Palmer, and B. Rowson (Univ. of Manchester, Eng.). Nature, 205: 375-6(Jan. 23, 1965).

The results of observations on quasi-stellar and unidentified radio sources using the improved 408-Mc/sec base-line interferometer at Jodrell bank are summarized and discussed in relation to previous observations and predictions. (D.C.W.)

14281 EVALUATION OF COSMIC RAY ENERGY AND MAGNETIC FIELD INTENSITY IN RADIOSOURCES. A. A. Korchak. Tr. Fiz. Inst., Akad. Nauk SSSR, 17: 149-60 (1962). (In Russian)

In order to develop cosmological theories and to clarify the nature of the radio emissions in the universe, the intensity H of the magnetic field, the total output P of the radiation, and the energy ξ of the relativistic particles and of the magnetic fields of the emitting sources must be known. The first evaluation of H, P and ξ by Berbidzh was further refined, assuming for the calculations that the radio emission of the observed sources possess a synchrotron character. Results of calculations involving 38 sources, among which are fragments of supernova explosions, radio galaxies and ordinary galaxies, are tabulated. The values obtained in the calculations are much larger than Berbidzh's data due to the fact that a more precise calculation method was used. In addition, the flux and spectral index data used are more accurate than those employed in the earlier calculation. Unfortunately, neither the present nor the previous method yield the true ξ value, but indicate only the necessary minimum value because the spectra are known only within certain frequency limits. As a simplifying assumption, the total energy of the relativistic particles was taken to be 100 times larger than the electron energy and equal to the magnetic field energy; the boundaries of the frequency spectrum were assumed to be 10^7 and 10^{10} hertz. (TTT)

14282 A CLOUD CHAMBER STUDY OF HIGH ENERGY NUCLEAR INTERACTIONS. Donald Roy Tompkins, Jr. Thesis, Tucson, Ariz., Univ. of Arizona, 1964, 157p.

Probably the chief problems in using a cosmic-ray beam to study nuclear interactions are the low counting rate, the determination of the energy of the incident particle, and the identification of the incident particle. Using a plastic scintillator as a target and recording the pulse height of the event in this scintillator helped increase the counting rate and gave information about the nature of the event. An air Čerenkov counter was placed above a multiplate cloud chamber. The counter control consisted of three scintillation counters, one above, one inside, and one below the chamber. The scintillator inside the chamber was also the target. The average energy of the penetrating showers was estimated by assuming that the average transverse momentum of all neutrons and charged secondaries depended only on the primary momentum and that it was a linear function of that momentum. This linear function was evaluated at two points by observing the threshold of Čerenkov emission for incident pions and for protons. Neutral pion energies were determined by measuring the associated electron showers in the iron plates. Laboratory system results are given based on 194 events classified as 0-7 Bev/c, 90 events classified as 7-14 Bev/c, 28 events classified as 14-28 Bev/c and 17 events classified as above 28 Bev/c. The electron cascade showers of 227 neutral pions were paired and the resulting neutral pion spectrum is presented. Eleven events with particularly small target scintillation pulses are believed to be proton-nucleon collisions. Center-of-momentum system results are given for these events assuming they are proton-proton collisions. (Dissertation Abstr., 25: No. 4, Oct. 1964)

Criticality Studies

14283 (KY-L-258(Rev.I)) THE DENSITY EFFECT—IN REGARDS TO THE MINIMUM CRITICAL ENRICHMENT OF AQUEOUS HOMOGENEOUS SOLUTIONS. O. W. Hermann (Paducah Gaseous Diffusion Plant, Ky.). Jan. 16, 1962. Contract [W-7405-eng-26]. 6p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

It is shown that the minimum critical enrichment of uranium in ^{235}U in aqueous homogeneous systems is independent of density. It is concluded that it should be possible to handle homogeneous or nominally homogeneous uranium salts without regard to density, so long as the minimum critical ^{235}U enrichment is not exceeded. (T.F.H.)

14284 TRANSPORT SOLUTIONS TO THE MONOENERGETIC CRITICAL PROBLEMS. George John Mitsis. Thesis, Ann Arbor, Mich., Univ of Michigan, 1963. 170p.

Transport solutions to the monoenergetic plane, spherical, and cylindrical critical problems with isotropic scattering are developed by the method of singular expansion modes. The results are given in the form of exact expressions for the neutron distributions and criticality conditions. These expressions depend on expansion coefficients which are shown to satisfy Fredholm integral equations of the second kind. Successive approximations on the coefficients lead to the asymptotic results of diffusion theory as well as to easily accessible transport corrections. The expansions for the neutron distributions are derived by two different, but equivalent, methods. In the first method a three-dimensional expansion for the angular density is developed from the elementary solutions of the transport equation and then specialized to the desired geometry. The second method consists of replacing the angular distributions by suitable density transforms and then determining the transforms completely with the aid of the integral equations for the neutron densities. In plane geometry this method leads to the conversion of the transport equation to a singular integral equation for the angular density. In spherical and cylindrical geometries the appropriate transforms are shown to satisfy separable equations whose solutions can be represented by unique expansions in terms of complete sets of singular expansion modes. The coefficients in the transform expansions are determined by resulting side conditions and the actual neutron distributions established by simple inversions. (Dissertation Abstr., 25: No. 4, Oct. 1964)

Direct Energy Conversion

14285 (AD-422661) RESEARCH ON CESIUM VAPOR. Final Report, May 1, 1963–September 30, 1963. A. O. Jensen (Electro-Optical Systems, Inc., Pasadena, Calif.). Oct. 30, 1963. Contract Nonr-3805(00). 43p. (EOS-3130-Final). $5.60(OTS).

The results of absolute absorption measurements near the resonance levels in cesium vapor show that, for cesium pressure ranges of interest to high-power-density cesium-vapor thermionic converters, the atonic resonance absorption at 8521 and 8943 angstroms is considerably greater than previously indicated. In addition to the resonance absorption, molecular absorption bands in the vicinity of 7600 angstroms are strong enough to furnish an additional significant source of energy input to the plasma of a cesium vapor thermionic converter. On the basis of absorption spectra, an ionization mechanism has been hypothesized for the production of the dominant ionic species for space-charge neutralization in high-pressure cesium-vapor thermionic-converter plasmas. The mechanism consists of cesium atoms first being excited to approximately the 1.45 ev level by resonance radiation from the emitter and subsequently colliding with other excited atoms to form the molecular cesium ion. Experiments indicate that in the presence of resonance radiation there is a definite enhancement of space-charge-limited currents, due to the hypothesized formation of the cesium molecular ion as the neutralizing agent. (auth)

14286 (AD-422728) NUCLEAR REGENERATIVE FUEL CELL. Final Report. (Union Carbide Consumer Products Co. Research Lab., Parma, Ohio). May 24, 1963. Contract NObs 78828. 83p. $8.10(OTS).

A redox closed-cycle fuel-cell system in which regeneration of cell feed materials is carried out by high-energy nuclear radiation is described. Electric output efficiencies up to 3% are predicted, based on absorbed radiation in an acidified, deoxygenated, aqueous ferrous-sulfate solution. A 5-watt prototype fuel cell unit was designed and constructed utilizing radiation reaction products of hydrogen ferric-ion-enriched ferrous sulfate electrolyte. Radiation chemistry, electrochemistry and prototype engineering design parameters are discussed. (auth)

14287 (AD-603681) EFFECTS OF PARTIAL CONDENSATION AROUND IONS IN ELECTRO-FLUID DYNAMIC ENERGY CONVERSION PROCESSES (thesis). John Alvern Decaire (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1964. 97p. (GSP/Phys/64-2). $3.00(OTS).

The direct conversion of fluid dynamic energy into electrical energy was investigated. The objectives were to experimentally observe the effect upon the performance of the process when colloids (condensation droplets) are used as the charge carriers and to determine theoretically the mobility of the charged droplets. Tests were made using water and carbon tetrachloride vapors and three initial pressures: 90, 180, and 270 psia. Test results show that the current and power outputs of the experimental generator are greatly increased when colloids rather than ions are used as the charge carriers. Observed current increases are about a factor 4 and power increases about one order of magnitude. Better results were obtained when water vapor was used. Carbon tetrachloride vapor proved to be very effective for the suppression of the corona discharge process. (auth)

14288 (AD-604736) HIGH TEMPERATURE THERMOELECTRIC GENERATOR. Quarterly Report Ending March 31, 1964. W. T. Hicks (Du Pont de Nemours (E. I.) & Co. Pigments Dept., Wilmington, Del.). Contract NObs-88639. 9p. $1.00(OTS).

The construction of modules for a 300-watt generator has been standardized, except for the air seal on the cold end of the modules. The segmented positive leg of the modules consists of a copper heat sink followed by a sodium-doped lead telluride cylinder and terminated by a tantalum-doped tungsten diselenide cylinder. The negative leg of the modules consists of a gold-nickel alloy strap, running (insulated) along one side and joined to the hot end of the positive leg. Satisfactory soldering and brazing methods for joining these elements have been developed. The assembly is encapsulated in a closed-end mullite tube. (auth)

14289 (CONF-640701-113) PERFORMANCE CHARACTERISTICS OF A LIQUID-METAL MHD GENERATOR. M. Petrick and Kung-You Lee (Argonne National Lab., Ill.). [1964]. Contract W-31-109-eng-38. 13p. Dep. (mn); $1.00(cy), 1(mn) OTS.

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The effects of the presence of the vapor phase upon the performance of a liquid-metal MHD generator are analyzed theoretically and experimentally. (T.F.H.)

14290 (EDR-3965) MEASUREMENT OF FLUID PROPERTIES FOR MAGNETOPLASMADYNAMIC POWER GENERATORS. Quarterly Technical Summary Report No. 5, May 1–July 31, 1964. R. T. Schneider (General Motors Corp. Allison Div., Indianapolis). Aug. 17, 1964. Contract Nonr-4104(00) and Amendment 1. 48p. (AD-604889). $2.00(OTS).

It was found that at low field strengths the generator voltage is proportional to the magnetic field strength. With increasing field strength the voltage deviates from this proportionality and finally saturates. A possible explanation of these phenomena is presented. The definition of one of the generator operational problems will allow a logical attack on the imposed limitations. The closed loop research facility has undergone several modifications to improve the operational and control characteristics. (auth)

14291 (GA-5552) ENERGY-TRANSFER CORRELATIONS ON A CYLINDRICAL CESIUM THERMIONIC CONVERTER. J. W. Holland (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 1, 1964. Contract AT(04-3)-167. 16p. (CONF-564-3). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Colloquium on Interaction Between Electromagnetic Waves and Plasma, Saclay, France, Sept. 1964.

Performance and energy-transfer measurements were obtained on a cylindrical cesium thermionic converter with an electrically heated emitter of vapor-deposited tungsten and a molybdenum collector at a radial spacing of 0.025 cm. From calorimeter data, a significant correlation was found for the prediction of emitter electron cooling and collector electron heating as functions of the converter current and electrode voltage. The error component of this correlation in predicting the emitter heat input is 4 percent or less over the operating variable range: emitter temperature 1200 to 1800°C; cesium reservoir temperature 300 to 400°C; collector temperature 600 to 700°C; and current 0 to 14 amp cm^{-2}. Through measurements of the emitter structure heat losses, the cesium vapor thermal conduction, and the electrode radiation heat transfer, it was found that computation of all zero current energy-transfer quantitites can be performed with a two-dimensional digital computer heat-transfer code. The electron cooling correlation, together with the ability to calculate all of the power loss values, makes it possible to compute the efficiency of a converter having only I-V characteristics and materials properties. (auth)

14292 (GA-5651) INTERNAL ENERGY LOSSES IN A CESIUM THERMIONIC CONVERTER. J. W. Holland (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 25, 1964. Contract AT(04-3)-167. 8p. (CONF-641011-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Thermionic Conversion Specialist Conference, Cleveland.

From measurements of heat transfer to the collector of a cesium thermionic converter, it was found that the electron waste heat to the collector is constant for a given emitter, collector, and cesium reservoir temperature. Electron energy return to the emitter up to 0.8 ev is explained by electron energy dissipation in collisions with cesium atoms with the energy returned to the emitter by

ion recombination. It was found that the minimum electron waste heat delivered to the collector coincided with the optimum cesium pressure. (auth)

14293 (GEST-2036) RESEARCH PROGRAM FOR THE LONG TERM TESTING OF CYLINDRICAL DIODES AND THE IRRADIATION OF FUEL AND INSULATOR. Quarterly Progress Report, March 18, 1964–June 17, 1964. (General Electric Co. Special Purpose Nuclear Systems Operation, Pleasanton, Calif.). Contract NAS 3-2544. 65p.

The development, design, fabrication, characteristics, and testing of nuclear thermionic converters are reported. The converters are single cell, cesium-filled, cylindrical devices, employing a tungsten-rhenium emitter and a niobium collector with an inter-electrode gap of 0.01-inch. The emitter is heated by a filament and electron bombardment. The filament is suspended within a tantalum emitter support sleeve. A significant feature of the STAR-C (Space Thermionic Auxiliary Reactor) is the integral thermionic fuel element consisting of 20 to 40 urania-fueled, series-connected, power converting diodes. (N.W.R.)

14294 (IPP-3/18) THEORETISCHE GRUNDLAGEN DER MAGNETOPLASMA-DYNAMISCHEN GENERATOREN. (Theoretical Fundamentals of Magnetoplasmadynamic Generators). R. Wienecke (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Feb. 1964. 18p. Dep. (mn).

The equations describing the MPD generator with a current velocity only in the x direction and the induction only in the z direction were derived. The power density and conductivity of the plasma were calculated. (J.S.R.)

14295 (MND-3149-2) THERMIONIC DOUBLE-DIODE PROGRAM. Quarterly Technical Progress Report, June 16–September 15, 1964. (Martin-Marietta Corp. Aerospace Div., Baltimore). Sept. 30, 1964. Contract AF33(615)-1289. 41p. (AD-606476) $1.00(OTS).

Fabrication of all components for two double-diode modules and test fixtures was completed. One module was assembled and outgassing initiated. Fabrication and pretest examination of the fueled emitters for the thermal endurance and vacuum emission tests have been completed. Preliminary testing has been initiated. (auth)

14296 ONE-DIMENSIONAL FLOW IN MHD GENERATORS. Edgar Bendor (Republic Aviation Corp., Farmingdale, N. Y.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 167-9(Jan. 1965).

A general solution of the one-dimensional flow equations for a segmented-electrode Faraday generator is presented, based on the assumption that the radio of loss of kinetic energy to loss of stagnation enthalpy is constant. Application of the results to closed-cycle power generation is briefly discussed. (D.C.W.)

14297 ACCELERATION OF A LIQUID STREAM BY A VAPOR STREAM FOR THE APPLICATION IN AN MHD GENERATOR. L. S. Dzung (Brown, Boveri and Cie, Baden, Switzerland). Brennstoff-Waerme-Kraft, 17: 13-16(Jan. 1965). (In German)

It has often been proposed that a liquid metal stream driven by a vapor stream of the same metal to high velocity be used for the application in MHD generators. The theoretical possibility of such an ejector was investigated from thermodynamical and fluid mechanical view points. The results indicate that the maximum of the attainable thermal efficiency is very low. (auth)

14298 PHENOMENA NEAR ELECTRODE SURFACES IN MHD GENERATOR. Toshio Ito and Tetsuya Morikawa (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Rept., 5: 435-52(Oct. 1964).

The analysis of the mechanisms of current exchange between the electrodes and the working fluid is an important problem for clarifying MHD electrical power generation phenomena. Analysis is made of open cycle MHD generators with graphite electrodes; the results of the experiments are reasonably explained by the theory. The conclusions obtained show that in the case of the generator with long operating time the electrodes spread the current uniformly over their surface area with voltage drop lower than the work function of the electrodes. On the other hand, in the case of the generator with short running time of a few seconds, the current path concentrates into a small spot on the cathode, causing considerable voltage drop over the electrodes. (auth)

14299 MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION. VOLS. 1, 2, 3, AND 4. Proceedings of an International Symposium held in Paris, July 1964. (European Nuclear Energy Agency, Paris and Organization for Economic Co-Operation and Development, Paris). 1964. 2042p. (CONF-640701). $34.; F 150; FS 134; DM 125; £11.

Physical properties of the MHD working fluid, MHD flows and power conversion processes, liquid metal and unconventional MHD conversion and a-c power generation, production of magnetic fields, problems of materials, and open- and closed-cycle converters are discussed. Separate abstracts for each of the 113 papers previously appeared in NSA. For individual abstract numbers see the Quarterly Report Number Index listing under CONF-640701. (C.E.S.)

14300 THE INFLUENCE OF THE RESIDUAL GAS ATMOSPHERE IN SPACE CHAMBERS ON THE NEUTRAL EFFLUX AND CRITICAL TEMPERATURE OF TUNGSTEN IONIZERS. O. K. Husmann, D. M. Jamba, and D. R. Denison (Hughes Aircraft Co., Malibu, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964. Paper No. 64-693, 48p, $1.00. (CONF-640801-35)

From 4th Electric Propulsion Conference, Philadelphia.

Tungsten surface ionizer efficiency frequently deteriorates as a result of the residual gas atmosphere in vacuum test chambers that are equipped with oil diffusion pumps and cryowalls. Changes in work function and critical temperature for cesium ionization caused by hydrocarbons and oxygen were investigated; these data are compared with measurements under clean surface conditions in an ultrahigh vacuum system. In addition, an ultrahigh vacuum system was used for a detailed study of surface effects caused by individual hydrocarbons with mass numbers between 16 and 128; this range is in accordance with the residual gas atomic mass number range measured in the space chambers. Measurements were taken with two types of apparatus: tungsten filaments were used to monitor changes in work function and in filament resistance resulting from carburization, and porous tungsten ion emission was used for observation of work function and critical temperature. Measurements indicate that a cryopumped space chamber with one of the liners at 22°K, combined with an ion pump, can be equivalent to an ultrahigh vacuum system. Small amounts of hydrocarbons as well as carbon monoxide and carbon dioxide reduce the work function and increase the critical temperature for surface ionization. Experiments with individual hydrocarbons confirmed that excessive amounts of hydrocarbons deposit pyrolytic graphite on the ionizer surface, resulting in a greater critical temperature than that of clean tungsten. (auth)

14301 CONCERNING THE NEED FOR SEEDING IN NONEQUILIBRIUM MAGNETOHYDRODYNAMIC GENERATOR CHANNELS. Frederic A. Lyman and Eli Reshotko (Lewis Research Center, Cleveland). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/ENER-10, 12p, $1.00. (CONF-763-10)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The various consequences of the addition of seed to a carrier gas in a magnetohydrodynamic (MHD) generator were examined. In particular a criterion was established for determining whether the net effect of seed addition is to augment or decrease the power density in MHD generator channels that use magnetically induced nonequilibrium ionization. The analysis considers the effects of electron-neutral collisions, electron-ion collisions, ion slip, and variation of the electron energy loss factor δ with seed fraction and seed material. Included in the consideration of ion slip are the effects of seed fraction and seed material

on ion-neutral collision frequency and on the relative drifts between seed ions and carrier ions. The presented criterion is based on the determination of a break-even condition, namely, that combination of gas density, magnetic field, and induced voltage for which the power density of the unseeded carrier is neither augmented nor decreased by the addition of seed. The formulation is given in general terms and is applicable for arbitrary combinations of monatomic carrier and seed materials. The criterion may be separately applied to each successive station of a segmented-electrode Faraday generator. Calculations of the break-even condition for various noble carrier gases with alkali seed were performed and are presented in graphical form. The results indicate that ion slip very strongly affects the break-even conditions. Generally speaking, seeding is desirable, and the most beneficial effects were obtained for heavy seed materials. (auth)

14302 STUDIES OF SEED RECOVERY AND CORROSION IN COAL FIRED MHD POWER PLANTS. F. Hals, L. Keefe, and A. El Bindari (Avco Corp., Everett, Mass.). New York, American Society of Mechanical Engineers, 1964, Preprint No. 64-WA/ENER-5, 16p, $1.00. (CONF-763-31).

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The results of a study of the problems of seed recovery and gas side corrosion effects due to seeding in coal-fired MHD power plants and application of these results to an assessment of the economics of seeding in a coal-fired MHD power plant are reported. A survey of the problems, a description of a potential recovery method and of apparatus to study experimentally the recovery method as well as corrosive effects due to seeding of the steam generator and oxidizer preheater utilizing the heat in the exhaust gases from the MHD generator are included. (P.C.H.)

14303 TWO-FLUID MAGNETOHYDRODYNAMIC SYSTEM AND METHOD FOR THERMAL-ELECTRIC POWER CONVERSION. James E. Webb (to National Aeronautics and Space Administration). U. S. Patent 3,158,764. Nov. 24, 1964. Filed July 25, 1962.

In the magnetohydrodynamic system described a liquid metal and gas mixture is caused to expand through a nozzle so that kinetic energy is imparted to the liquid metal. The high-velocity liquid metal is then immediately separated from the gas and caused to flow through a magnetic field in such a manner as to establish current flow through the liquid, which may be withdrawn as electrical energy. None of the several systems suggested for separating the fluids requires use of mechanical moving parts, and the system can operate at a lower temperature than is possible with a single-fluid system. (A.G.W.)

14304 WALL STRUCTURE FOR AN MHD GENERATOR. Frederick B. Russell (to Avco Corp.). U. S. Patent 3,161,788. Dec. 15, 1964. Filed Dec. 2, 1960.

The wall structure described has good thermal conductivity in a direction perpendicular to its surface but substantially no electrical conductivity in the plane of the wall. Essentially the structure consists of individual metal rods secured to parallel, spaced, electrically nonconductive plates. The rods project into the interior of the generator duct and are spaced from one another to accommodate an electrically nonconductive refractory disposed between the rods and flush with their projecting ends to form a smooth interior for the generator duct. A cooling medium may be circulated in the space between the parallel plates to dissipate the heat transferred by the rods. The wall is strong enough to withstand the pressures present in an MHD generator. (A.G.W.)

14305 MHD POWER GENERATION. Henry T. Nagamatau, Joseph R. Schmid, and Russell E. Sheer, Jr. (to General Electric Co.). U. S. Patent 3,161,789. Dec. 15, 1964. Filed Jan. 23, 1961.

A method of operating an MHD device with a cold cathode for substantial electric power output is described. A shock tunnel technique is used to pass a hot ionized plasma through a magnetic field and between a pair of electrodes at 10 to 32 times the speed of sound. The temperature of the plasma is maintained at about 3600 to 11000°K, and a magnetic field strength of at least about 2300 gauss is used. The temperature of the electrodes is kept below about 1100°C. (A.G.W.)

14306 THERMOTUNNEL CONVERTER. F. N. Huffman (to U. S. Atomic Energy Commission). U. S. Patent 3,169,200. Feb. 9, 1965.

A "Thermotunnel Converter," which is a device for converting thermal energy into electrical energy, is described. It consists of alternately spaced electron emitting and collecting surfaces with an effective gap width of less than 40 angstroms between surfaces. A temperature gradient is created between adjacent surfaces to cause a transfer of electrons across the gap by the quantum mechanical tunnel effect. (AEC)

Elementary Particles and Radiations

Refer also to abstracts 14227, 14622, and 14626.

14307 (ANL-6942) UNITARY SYMMETRY FOR PEDESTRIANS (OR, I-SPIN, U-SPIN, V-ALL SPIN FOR I-SPIN). H. J. Lipkin (Weizmann Inst. of Science, Rehovoth, Israel and Argonne National Lab., Ill.). Sept. 1964. Contract W-31-109-eng-38. 31p. Dep.; $2.00(cy), 1(mn) CFSTI.

Unitary symmetry of elementary particles is described in a simple way requiring no knowledge of group theory. The basic approach is that of Levinson, Lipkin, and Meshkov, and uses SU_2 subgroups of the group SU_3. Unitary symmetry appears as a generalization of I-spin symmetry, in which three spins are defined in a symmetrical way and are all required simultaneously to be conserved. One of the three spins is I-spin; the other two, called U spin and V spin, define certain transformations between particles of different strangeness. Experimental consequences of the conservation of all three spins are calculated with conventional angular momentum algebra. The breaking of unitary symmetry by electromagnetic interactions and by the strong interactions producing mass splittings leads to consequences which are easily calculated with the use of the three spins and angular momentum algebra. (auth)

14308 (BNL-888) NATURE OF MATTER. PURPOSES OF HIGH-ENERGY PHYSICS. Luke C. L. Yuan, ed. (Brookhaven National Lab., Upton, N. Y.). Jan. 1965. Contract [AT(30-2)-Gen-16]. 154p. $1.75(cy), 3(mn) OTS.

The purposes of high-energy physics and the associated problems are discussed. The nature of matter, the laws that govern it, and the language in which it should be described are considered. Most of the problems are associated with the need to extend present knowledge to the super high energy region of multi-hundred Bev. The feasibility of super high energy accelerators is discussed. (C.E.S.)

14309 (BNL-8509) EXPERIMENTAL INVESTIGATIONS OF SEVERAL FEW-NUCLEON SYSTEMS. Paul F. Donovan (Bell Telephone Labs., Inc., Murray Hill, N. J. and Brookhaven National Lab., Upton, N. Y.). Oct. 13, 1964. Contract AT-30-2-GEN-16. 30p. (CONF-641005-1). Dep.(mn); $3.00(cy), 1(mn) OTS.

From Correlation of Particles Emitted in Nuclear Reactions, Gatlinburg, Tenn.

The experimental features of some interactions and reactions of the type $1 + 2 \rightarrow 3 + 4 + 5$ are described. The use and usefulness of on-line computer and "data simulation" techniques are also described. The kinematics and mechanisms for the reactions are discussed. The incident particles include H_2^+, d, ^3He, and α particles. Particular attention is paid to $d + p \rightarrow p + p + n$, $d + d \rightarrow d + p + n$, and $^3He + D \rightarrow p + {}^4He^*$. (T.F.H.)

14310 (BNL-8526) FINAL-STATE INTERACTIONS AND SPECTATOR POLES IN FEW-NUCLEON SYSTEMS.

Paul F. Donovan (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT-30-2-GEN-16. 11p. (CONF-811-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

From 9th Yugoslavian Summer Meeting of Physicists, Hercegnoui, Yugoslavia, July 1964.

Energy systematics in the interactions d + p → p + p + n and d + d → d + p + n are analyzed using a computer, and the results are compared with experimental values. The effects of spectator poles and the three-body final-state interactions on the kinematics are discussed. (T.F.H.)

14311 (COO-264-215) SU(3) SYMMETRY IN THE STRONG-COUPLING LIMIT. G. Wentzel (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies). [1963]. Contract [AT(11-1)-264]. 11p. (EFINS-64-33). Dep.(mn); $1.00(cy), 1(mn) OTS.

The static strong-coupling approximation is applied to SU_3 symmetric Yukawa interactions, in an attempt to predict the types of bound or resonant baryon–meson states (isobars) that might be expected, for various SU_3 symmetric models, in the limit of very large coupling strength. (T.F.H.)

14312 (CU-233) THE BRANCHING RATIO FOR PION BETA DECAY (thesis). David Bartlett (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Nov. 1964. Contract Nonr-266(72). 107p. (NEVIS-127; R-468).

The conserved vector current theory predicts that the branching ratio for the decay of a charged pion into a neutral pion is $(1.05 \pm 0.02) \times 10^{-8}$, if the coupling constant is derived from muon decay, or $(1.00 \pm 0.02) \times 10^{-8}$, if the coupling constant is derived from nuclear beta decay. Using spark chambers to distinguish the nearly anticollinear gamma rays from π^+ beta decay from a background of other gamma rays, 36 events are found and the branching ratio is measured to be $(0.97 \pm 0.20) \times 10^{-8}$, in agreement with the theoretical prediction and previous measurements. The method of background subtraction ($\lesssim 10\%$) depends only on knowing that the background is isotropic for gamma rays having opening angles between 160 and 180°. (auth)

14313 (JINR-E-1894) ON A CALCULATION OF THE EFFECTIVE RANGE EXPANSION PARAMETERS FOR LOW-ENERGY NN POTENTIAL SCATTERING. V. V. Babikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 13p. Dep.(mn).

The methods are given which permit accurate calculations of the low-energy nucleon-nucleon scattering parameters. The Coulomb potential is taken into account exactly for $^1S_0$ pp scattering. The effect of tensor forces in the $^3S_1$ np state is also considered. By means of the methods the scattering lengths, the effective ranges and the shape parameters are computed for a number of NN potentials with hard and soft cores. (auth)

14314 (JINR-P-1887) REZONANSY S NULEVOI STRANNOST'YU. (Zero Strangeness Resonances). S. Ya. Nikitin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 60p. (CONF-550-86) Dep.(mn).

From the International Conference on High-Energy Physics, Dubna, USSR, Aug. 1964.

An analysis was made of the experimental data on resonances with zero strangeness in relation to their quantum numbers and their behavior in various reactions. The properties of mesons (η^0), mesons (ρ), mesons (f^0), $\pi\pi\eta$ resonance, A resonance, mesons (E) ($K\bar{K}\pi$ resonance at 1410 Mev) mesons (θ), and baryon resonances are reviewed. (R.V.J.)

14315 (JINR-P-1891) KINEMATICHESKIE RASCHETY DLYA PROTSESSOV S OBRAZOVANIEM I KASKADNYM RASPADOM IZOBAR. (Kinematic Calculations for Processes Involving Formation and Cascade Decay of Isobars). V. F. Vishnevskii, Yuan-tsai Tu, V. I. Moroz, A. V. Nikitin, Yu. A. Troyan, Shao-chun Chiang, Wen-yu Chang, B. A. Shakhbazyan, Jung-fang Yuan, and Wu-kuang Yen (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 14p. Dep.(mn).

The kinematic calculations are carried out for the cascade processes: X + N → A + B, A → α + β, α → a + b, where particle a is to be under observation. Its kinematic quantities are expressed respectively in the center-of-mass systems of α, A, and (XN). It is found that its momentum P_a and angle of emission θ_a have a simple relation, which has the same form in the systems of (XN) center-of-mass and that of laboratory. The two essential kinematic parameters, q (transverse momentum) and η (elasticity), both of A, may be chosen from experimental data. The above relation was used for concrete cascade processes of isobars to explain the momentum groups of hyperons (Λ) as found in the experiments of π^-p interactions. (auth)

14316 (JINR-P-1892) K VOPROSU O PRIMENIMOSTI IZOBARNOI MODELI OBRAZOVANIYA Λ-GIPERONOV V π^--p VZAIMODEIST-VIYAKH. (On an Applicability of the Isobar Model for the Λ-Hyperon Production in π^--p Interactions). V. F. Vishnevskii, Yuan-tsai Du, V. I. Moroz, A. V. Nikitin, Yu. A. Troyan, Shao-chun Chiang, Wen-yu Chuang, B. A. Shakhbazyan, and Wu-kuang Yen (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 9p. Dep.(mn).

Data on Λ hyperon production in π^--p interactions at the momenta of 10 and 16 Bev/c were analyzed. It was assumed that Λ hyperons are generated in two-body reactions of the type π^- p → A + B, where A may be either a Λ hyperon or one of the isobars that decays into a Λ hyperon. The experimental data agree with the results of the analysis. (auth)

14317 (JINR-P-1896) MEKHANIZM ISPUSKANIYA ZHESTKIKH γ-KVANTOV V REATSTII π + N → π + γ + N. (A Mechanism of Emission of Hard γ Quanta in the Reaction π + N → π + γ + N). V. A. Meshcheryakov, L. L. Nemenov, L. D. Solovev, P. Strokach, and F. G. Tkebuchava (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 10p. Dep.(mn).

A mechanism of emission of hard photons in the pion-nucleon interaction is considered. The formulas obtained are compared with experimental data. The constant of the γ + π → π + π process is estimated. (auth)

14318 (JINR-P-1906) NARUSHENIE SIMMETRII PRONITSAEMOSTI BAR'EROV DLYA SLOZHNYKH CHASTITS. (A Violation of Barrier Penetrations Symmetry for Complex Particles). I. Amirkhanov and B. N. Zakhar'ev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 16p. Dep.(mn).

The penetration of any barriers in opposite directions is strictly identical for elementary particles. But for complex particles, at any energy sufficient for the real excitation of the higher states of internal motion the penetration coefficients through the non-symmetrical barriers in opposite directions may be essentially different. (auth)

14319 (JINR-P-1910) VERSHINNAYA FUNKTSIYA V NEPERENORMIRUEMOI TEORII POLYA. (Vertex Function in Nonrenormalizable Field Theory). B. A. Arbuzov and A. T. Filippov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 19p. Dep.(mn).

An approximate equation is considered for the vertex function Γ_μ in the nonrenormalizable field theory of interaction between the scalar particles and the massive vector ones. The possibility of formulating some renormalization procedure for the removal of divergences is shown. An iteration method for solving the equation for Γ_μ is developed. It consists of a successive solution of some simple integral equations. The solutions of these equations are studied, and the existence of the unique solution for the renormalized vertex function is proved. This solution is free from divergences, decreases at infinity in the complex p^2 plane, and has the logarithmic branch point at $g^2 = 0$ (the terms of the form $g^2 \log g^2$). (auth)

14320 (JINR-P-1912) DAL'NEISHEE UTOCHNENIE FAZOVYKH SDVIGOV p-p RASSEYANIYA PRI 435 Mev. (A Study of p-p Scattering Shifts at 435 Mev). L. S.

Ashgirei (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 6p. Dep. (mn).

Using new data on the triple scattering parameters D, R, A, and A′ a set of p-p scattering phase shifts at 435 Mev was made. All the data on p-p scattering available near this energy may be statistically satisfactorily described by a set of the phase shifts and absorption coefficients, which are given. (auth)

14321 (NP-14631) EFFETS INELASTIQUES DANS LA DIFFUSION MUON-PROTON A GRAND TRANSFERT (thèse). (Inelastic Effects in High-Transfer Muon-Proton Scattering (thesis)). Jean-Marie Abillon (Paris. Université). [1963]. 40p. Dep.(mn).

The effects of bremmstrahlung and production of π mesons in high-transfer μ-p scattering are calculated. (J.S.R.)

14322 (NP-14637) CORRELATIONS ENTRE PARTICULES ESTRANGES PRODUITES DANS LES INTERACTIONS PION-NUCLEON A 6, 11 ET 18 Gev (thèses). (Correlations Between Strange Particles Produced in Pion-Nucleon Interactions at 6, 11, and 18 Gev (thesis)). Michel Bloch (Paris. Université). [1963]. 64p. Dep.(mn).

The production of strange particles in π-N interactions at 6, 11, and 18 Bev was studied in a bubble chamber at the CERN 25-Bev proton accelerator. The experimental apparatus is described. The criteria used for the selection of the events, the methods used for their measurement, and the classification of the events in pairs of KΛ and $K\overline{K}$ by taking into consideration the cases where the identification of a V^0 is impossible are discussed. The results relative to the production of $K^0\overline{K}^0$ and $K^0\Lambda^0$ pairs are presented and discussed differently since they are the results of different physical phenomena. In interactions with emission of pions only, the collisions that produce pairs of associated strange particles are peripheral collisions. There is a striking correlation between the two K_1^0 mesons observed in the production of $K\overline{K}$ pairs. The dominant phenomenon in the production of K pairs at 6 Bev is the formation of resonant states. (J.S.R.)

14323 (TID-20450) K^--p TOTAL AND ELASTIC CROSS SECTIONS AT 1.34 Bev/c. R. I. Hulsizer, J. R. Ficenec, D. W. Mortara, J. N. Snyder, W. P. Swanson, and W. P. Trower (Illinois. Univ., Urbana). [1964]. Contract AT(11-1)-1195. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A total of 15,000 stereo triads produced by the 72-in. hydrogen bubble chamber operating in a (1336 ± 47)-Mev/c meson(K^-) beam was scanned. Two-prong events accounted for 5,363 interactions of which 94% were successfully measured to determine the differential and integrated elastic cross sections. (C.E.S.)

14324 (TID-21438) A NEW MEASUREMENT OF THE K^0-K^- MASS DIFFERENCE. Technical Report No. 430. R. A. Burnstein and H. A. Rubin (Maryland. Univ., College Park). Jan. 1965. Contract [AT(40-1)-2504]. 9p. Dep. (mn); $1.00(cy), 1(mn) OTS.

The $\overline{K}^0 - K^-$ mass difference has been measured to be 2.90 ± 0.25 Mev. The method employed involves the observation of nine examples of the reaction $K^- + p \rightarrow \overline{K}^0 + n + \pi^+ + \pi^-$ in association with the proton recoil from the scattered neutron. The kinematic fitting of this event in the bubble chamber is very sensitive to the $\overline{K}^0 - K^-$ mass difference. Sources of systematic errors are also discussed. (auth)

14325 (UCRL-1011) NUCLEON-NUCLEON INTERACTION (thesis). Richard Stuart Christian (California. Univ., Berkeley. Radiation Lab.). [195?]. Contract W-7405-eng-48. 101p. Dep.(mn); $4.00(cy), 2(mn) OTS.

Several models for the nucleon potential are considered that reproduce the experimental data at low energies. These models are extended to high energies, and the model predictions are compared with experimental results. No attempt is made to introduce relativistic corrections. (T.F.H.)

14326 (UCRL-7655) RESONANT CHARGE TRANSFER IN PROTONS ON HYDROGEN. M. H. Mittleman (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 31, 1964. Contract W-7405-eng-48. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An exact theory of the coupled equations describing charge transfer in the p + H system is derived. Previous approximations are shown to have neglected terms of the same order as those which they kept. An experiment of Everhart is shown to be in probable disagreement with the theory presented. (auth)

14327 (UCRL-11151) A LIMITATION ON THE NUMBER OF PARTICLES GENERATED BY BOOTSTRAP DYNAMICS. Geoffrey F. Chew (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 3, 1963. Contract W-7405-eng-48. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The constraint imposed in bootstrap dynamics by the simultaneous requirement of unitarity in the different reactions connected by analytic continuation is discussed. A simple aspect of this constraint is explored. This aspect is that the total attractive force in any set of coupled channels shall not be too strong as to raise any Regge trajectory above the Froissart limit of J = 1 at zero energy. It is argued that this requirement can eliminate candidates for the solution of the self-consistent bootstrap. In particular, since each particle contributes to the forces, a limitation on force strength may limit the number of particles that can exist. (C.E.S.)

14328 (UCRL-11219) ON THE THREE-BODY SCATTERING AMPLITUDE. III. SCATTERING ON A BOUND STATE. Roland L. Omnes (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 16, 1964. Contract W-7405-eng-48. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The previous results are carried on to a formulation of the Fadeev equations due to C. Lovelace. This allows showing that the nonrelativistic scattering amplitude for an elementary particle on a bound state is a meromorphic function of the total angular momentum. An extension of the helicity amplitudes to complex values of the total angular momentum and of the spin of the bound state is indicated. One is thus able to define the scattering amplitude for a particle on a Regge pole when the energy of the Regge pole is in the physical sheet. (auth)

14329 (UCRL-11344) RECENT DEVELOPMENTS IN THE THEORY OF WEAK INTERACTIONS. Lecture Notes I Through VII. Nicola Cabibbo (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 17, 1964. Contract W-7405-eng-48. 94p. Dep.; $3.00(cy), 2(mn) CFSTI.

Lecture notes are presented, covering such topics as: the experimental basis of the A-V theory; the conserved-vector-current theory; neutrino reactions; lepton processes, especially muon–electron universality and the two-neutrino hypothesis; the Goldberger and Treiman relations and quasi-conserved currents; universality and SU_3 symmetry; and the relations of nonleptonic decays with SU_3 symmetry. (T.F.H.)

14330 (UR-875-24) A BOUNDARY CONDITION MODEL. I. ANTINUCLEON-NUCLEON SCATTERING. Martin S. Spergel (Rochester, N. Y. Univ.). Mar. 6, 1964. Contract AT(30-1)-875. 43p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

An improved boundary condition plus elastic potential was developed for calculating the elastic, charge exchange, and annihilation cross sections for the antinucleon-nucleon system in the nonrelativistic energy region (50–300 Mev in the laboratory system). The boundary condition is taken to maximize the absorption cross section in each channel of specified isotopic spin, ordinary spin, and total angular momentum. The elastic potential is constructed by modifying the one pion and two pion nucleon-nucleon potentials in the usual manner. The results fit the available data fairly well for both the differential elastic cross section and the total annihilation cross section. Charge-exchange scattering is found to be quite sensitive to the size of the core region. (auth)

14331 (CEA-tr-R-1814) SUR L'EXISTENCE D'UN POTENTIEL D'INTERACTION DES NUCLÉONS NE CONSERVANT PAS LA PARITÉ SPATIALE. (On the Existence of an Interaction Potential for Nucleons Not Conserving Spatial Parity). Yu. G. Abov, P. A. Krupchitskii, and Yu. A. Oratovskii (U.S.S.R.). Translated into French. 1964. 30p. Dep.(mn); $2.60(fs), $1.10(mf) JCL.

The universal theory of weak interactions with 4 fermions predicts the existence of an internucleonic potential not conserving spatial parity. The coefficient of asymmetry of the angular distribution of γ rays emitted by the ^{114*}Cd nucleus after capture of polarized neutrons was measured. The γ rays were recorded by two identical scintillation spectrometers, provided with sodium iodide crystals selecting the γ rays from the ground transition of ^{114*}Cd at the angles $\theta_1 = 0°$ and $\theta_2 = 180°$ with respect to the direction of the neutron spins. The effect of instability of the apparatus was reduced to the minimum because of a rapid comparison of the effects of polarized and non-polarized neutrons with the aid of a rotating depolarizer. In order to eliminate the asymmetry effect of the apparatus, measurements were made with two opposing spin directions, as well as after inversion of the two spectrometers. Control experiments were made that showed that the asymmetry of the apparatus was completely eliminated. The coefficient of asymmetry was found equal to $a = -(3.7 \pm 1.0) \times 10^{-4}$, so that the ratio of parity-nonconserving potential/parity-conserving potential is given by $F \simeq 4 \times 10^{-7}$. (tr-auth)

14332 QUANTUM STATISTICS AND PION DECAY OF PROTONIUM. F. J. Yndurain (Universidad, Zaragoza, Spain). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 60: 75-8(Mar.-Apr. 1964). (In Spanish)

The statistics obeyed by pions is analyzed in connection with the pionic decays of protonium. The possibility of deviation from ordinary statistics is taken into account. The conclusion is drawn that pions obey base statistics, or, at least, do not deviate from it by more than ~15%. (auth)

14333 THE CLASSICAL EQUATION OF MOTION OF A CHARGED PARTICLE. Vittorio Cantoni (Consiglio Nazionale delle Ricerche, Rome.). Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat., 36: 461-6 (Apr. 1964). (In Italian)

The Lorentz-Dirac motion equations are given, and their inherent difficulties are shown. An attempt is made to substitute another criteria for the determination of motion that is valid without restriction and is physically more acceptable. (J.S.R.)

14334 LOSS OF ENERGY OF ULTRARELATIVISTIC MESONS. I. NUCLEAR INTERACTIONS. Carlo Castagnoli, Angelo De Marco, and Renato Scrimaglio (Universita, Turin). Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat., 36: 475-80(Apr. 1964). (In Italian)

The energy loss of mesons (μ) of ultrarelativistic energy is studied in order to facilitate the interpretation of the results obtained on the ultrapenetrating behavior of cosmic radiation. The contribution to the loss by nuclear interactions is still uncertain. The energy loss of mesons (μ) from nuclear interactions is recalculated. The theoretical formulation of the virtual photon spectra accompanying the mesons (μ) and the cross section $\sigma\gamma$ of real photons against nuclei are re-examined by introduction of the Kessler-Kessler theory in place of the Weiszacker-Williams theory. The data obtained directly on $\sigma\gamma$ at an energy of ~1.1 Bev with the Frascati synchrotron are used. (J.S.R.)

14335 EXPECTED ENERGY PEAKS IN MESON-MESON INTERACTION. Charles Thompson (Marquardt Corp., Orange, Calif.). Can. J. Phys., 43: 163-7(Jan. 1965).

The nature of unstable meson-meson interactions is considered. A discussion is given of the type of energy peaks expected on the basis of the crossed one-meson exchange diagram where the unstable vertices represent decay vertices and can lead to singularities near the physical region and whether such peaks will actually appear in the three-body final-state interaction when the diagram is joined by unitarity to the final (and initial) system involving stable mesons only. (C.E.S.)

14336 COMPLETE JOST FUNCTIONS. M. Petras (Komensky Univ., Bratislava). Czech. J. Phys., 14: 895-909(1964). (In Czech)

The properties of complete Jost functions $\varphi(k, \cos\vartheta)$ defined by a series are investigated. A system of equations is given for the simultaneous determination of the scattering amplitude and the complete Jost function from the potential. A new method is used to derive the De Alfaro, Regge, and Rossetti dynamic equation for Jost functions. (auth)

14337 SELF-CONSISTENT APPROACH TO LOW-ENERGY RESONANCE. RESONANCES OF $\pi-N$ SYSTEM. V. Sachl (Inst. of Radio Engineering and Electronics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 15: 1-9(1965).

A method is worked out for determining the position of low-energy P, D-resonances of an arbitrary two-particle system with a strong interaction on the assumption that the values of the partial-wave amplitude and its first derivative are known in one point $S_F = S_0$. This is made possible by the modification of Balázs' N/D method for two unknown parameters F_l^j using the elastic approximation. Although the other l-states of the system in the function N_l^j are generally contained in the three- or two-pole form mentioned, in spite of the asymptotic behavior of the amplitudes they can not be consistent with the approximation used. The explicit solution with a generally given subtraction point s_0 is obtained for the $\pi-N$ system. (auth)

14338 POLARIZATION EFFECTS IN DISPERSION RELATIONS FOR PHOTOPRODUCTION OF π-MESONS ON DEUTERONS. V. Sachl (Inst. of Radio Engineering and Electronics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 15: 10-16(1965).

The photoproduction amplitude of mesons (π^0) on deuterons is calculated for different cases of polarization of the spin of deuterons by means of impulse approximation. The calculations carried out in the two-nucleon approximation in the Breit system are valid up to a maximum photon energy ~236 Mev. In the unobservable region only a free proton and a free neutron contribute to the continuous part of the spectrum. The dispersion relations are given for all cases of deuteron-spin polarization. (auth)

14339 ON THE PROBLEM OF ELASTIC $\bar{p}$-p INTERACTION. I. G. Golyak. Izv. Akad. Nauk Kaz, SSR, Ser. Fiz.-Mat. Nauk, No. 1, 79-82(Jan.-Apr. 1964). (In Russian)

A formula is derived for elastic $\bar{p}$-p scattering at energies above 250 Mev by using the usual pole diagrams with the exchange of a meson (π). The cross section for elastic scattering σ_{el} and $d\sigma_{el}/d\Omega$ is derived in a manner analogous to that used for positron-electron scattering, except that for the nodes of the diagram a matrix γ_5 must be used instead of γ_μ to obtain the elastic-scattering matrix elements. The result for σ_{el} are in good agreement with experimental data. However, the calculated values of $d\sigma_{el}/d\Omega$ are almost isotropic in center-of-mass coordinates, while available experimental data show strong peaking in the forward direction. The difference can be explained by the lack of integration over the four-momentum of the intermediate particle. (TTT)

14340 NUCLEON-ANTINUCLEON SCATTERING AT INTERMEDIATE ENERGIES. I. G. Golyak and V. I. Rus'kin. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 83-7(Jan.-Apr. 1964). (In Russian)

Equations are presented for the total scattering cross section and the angular distribution in the center-of-mass system for nucleon-antinucleon scattering. The equations are applicable for incident antinucleon energies of 0.1 to 1.3 Bev (in the laboratory system). Vector, pseudovector, and scalar processes are considered for cases in which a resonon from the meson (π) system is exchanged in the scattering pole processes. Numerical values are calculated for proton-antiproton scattering and are compared with available experimental data. Resonon energies of 370, 530, 830, and 1600 Mev are considered with an isospin T = (0,1). The scalar resonance at 370 Mev gives

the best fit to angular distribution data. The scattering data can also be fitted with a scalar resonon at 395 Mev with T = 0. The small values of the experimental charge exchange reaction ($p + \bar{p} \rightarrow n + \bar{n}$) also points to the important role of this resonon and to the small role of the annihilation channel in these processes. (TTT)

14341 PROTON-ANTIPROTON ANNIHILATION AND TRIPLE-PION RESONANCES. V. I. Rus'kin and T. A. Bobryasheva. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 88-91(Jan.-Apr. 1964). (In Russian)

Two processes are considered for the annihilation of a proton and antiproton at rest: $p + \bar{p} \rightarrow \omega + \pi \rightarrow (\pi + \pi + \pi) + \pi$ and $p + \bar{p} \rightarrow \eta + \pi \rightarrow (\pi + \pi + \pi) + \pi$. For the first reaction the calculated multiplicity of mesons (π) $\langle n_\pi \rangle = 4.9$; the percentage of annihilations by a $K\bar{K}$ meson pair was calculated to be $P_K = 2\%$. For the second case, calculations gave $\langle n_\pi \rangle = 5.0$ and $P_K = 1.6\%$. Experimentally $\langle n_\pi \rangle = 4.7 \pm 0.1$ and $P_K = (3 \pm 1)\%$. Statistical weights were calculated for the formation of 2–7 mesons (π), 2 mesons (K), 2K and 2π mesons, and 2K and one π meson, using the assumption that both η and ω mesons are formed and that only ω mesons are formed. The number of rays in the annihilation stars were calculated for the cases in which ω and η mesons, respectively, are formed; the results compare favorably with experimental data. Since none of the available experimental data on $p\bar{p}$ annihilation depend strongly on the mass of the resonance (η or ω), it is difficult to tell which resonance is the more important. The formation of triple pion resonances has a strong effect on the calculated angular distribution of mesons (π) formed in the $p\bar{p}$ annihilation. (TTT)

14342 SOME RESULTS OF ISOSPIN ANALYSIS OF STRONG INTERACTIONS. V. I. Rus'kin and Yu. T. Lyutov. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 92-9(Jan.-Apr. 1964). (In Russian)

Because of the large number of processes which are energetically possible in strong interactions it is often difficult to decide which of the processes are most important. From the principle of isospin invariance it is possible to calculate the asymmetry coefficient α associated with the possible interactions. Then angular distributions calculated with various combinations of the possible interactions may be compared with the experimental distributions to determine the important processes. The method is applied to p-n interactions at 1.5 Bev, where it is shown that the reactions $p + n \rightarrow p + p + \pi^-$, $p + n \rightarrow 2p + \pi^- + \pi^0$, and $p + n \rightarrow p + n + \pi^+ + \pi^-$ occur with probabilities of 0.88, 0.05, and 0.07 respectively. The method is also applied to π^--N interactions at 7.5 Bev. Here, a combination of four processes is necessary to satisfy energy and angle correlations. (TTT)

14343 NEUTRINO SCATTERING OF AN ELECTRON WITH LONGITUDINAL AND TRANSVERSE POLARIZATION. A. A. Sokolov (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 51-7(1964). (In Russian)

It is shown that the degree of longitudinal and transverse polarization of recoil electrons (muons) in the case of V-A variation depends only on the helicity of the primary neutrino and on the lepton charge, i.e., on whether the neutrino or antineutrino is scattered on the electron (positron), and does not depend on the orientation of the spin of the primary electron. (tr-auth)

14344 A COMPLEX SPACE VARIATION IN THE THEORY OF ELEMENTARY PARTICLES. Wang-fu Tsyong (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 71-6(1964). (In Russian)

A complex generalized space is studied, assuming that the imaginary spatial coordinates correspond to the internal space. In contrast to the usual theories, the nonlinear generalization of the field equations is carried out in the interior space, equations in the usual space being left to linear generalization. Due to the Euclidean character of the internal space, the causal function is free from divergence and provides the possibility of calculating the rest masses of particles by the method of superconductivity, but without cutoff. By this method numerical values are obtained for masses of stable fermions, in agreement with results of other works. The classification of the indicated particles is also given. (tr-auth)

14345 PARTICLE SCATTERING IN A SPHERICALLY-SYMMETRICAL GRAVITATIONAL FIELD. Yu. S. Vladimirov (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 82-5(1964). (In Russian)

A calculation of the scattering cross section of spinor and vector particles on a spherically symmetric gravitational field is carried out on the basis of the quantum theory of a weak gravitational field. The cross sections obtained for small scattering angles agree with the analogous scattering cross section of scalar particles. (tr-auth)

14346 BETA-DECAY OF A POLARIZED NEUTRON IN A MAGNETIC FIELD. L. I. Korovina (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 86-92(1964). (In Russian)

The effect of the magnetic field on the character of polarized neutron β decay in a magnetic field is studied. Expressions are obtained for the energy spectrum of the emitted electrons, the angular distribution of the antineutrinos, and the total decay probability. (tr-auth)

14347 ELECTROMAGNETIC FORM FACTOR OF PI-MESON IN REGGE THEORY. Yu. G. Pavienko (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 93-5(1964). (In Russian)

The contribution of the Regge-ized ρ meson to the electromagnetic form factor of the π meson is found, assuming that the hypothesis of the Regge-ness of the photon and strongly interacting particles is valid. By means of the Regge-ization of the perturbation-theory diagrams for the process $\pi + \pi \rightarrow e + \bar{e}$ the form factor is obtained in the form proposed by Clementel and Villi, depending on the slope of the photon and ρ-meson trajectories and of the two products. Since a dynamic theory of Regge poles does not exist, the products are determined by comparison with results of calculation of form factors by the method of dispersion relations. (tr-auth)

14348 PROBLEMS OF NONLINEAR THEORY OF ELEMENTARY PARTICLES. PART II. D. F. Kurdgelaidze (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 96-103(1964). (In Russian)

An attempt was made to approach the question of the mass spectrum of mesons from various points of view. The possibility of a concrete model of representation of meson resonances as aggregates of several π mesons is analyzed, and their line widths are calculated. It is shown that the latter are in qualitative agreement with experiment. On the base of the nonlinear relativistic-invariant equation (of the Kemmer-Duffin type) the mass spectrum of mesons is determined (of type $E_n = E_\pi n^{3/2}$, n 0, 1, 2, . . .), and it is shown that the spectrum thus obtained is an analytic generalization of the phenomenological mass spectrum obtained first. (tr-auth)

14349 PROBLEMS OF NONLINEAR THEORY OF ELEMENTARY PARTICLES. PART III. D. F. Kurdgelaidze (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 104-10(1964). (In Russian)

The stability of an elementary particle treated as a nonlinear field formation of finite dimension is studied, and it is shown that in nonlinear theory a similar stable formation can exist. A method of describing unstable particles in the limits of nonlinear field theory is developed. (M.J.T.)

14350 THEORY OF NONRELATIVISTIC SCATTERING OF COMPLEX PARTICLES. A. M. Brodskii and D. D. Ivanenko (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 130-5(1964). (In Russian)

The scattering of a system composed of two spinless particles by a third spinless particle is considered. The time-independent Schroedinger equation is given, and conditions on the material pair potentials of the interactions of the three particles are given. The solutions are expanded for total moment and its projection using spherical harmonics and material Wigner coefficients. The Hermitian

matrix is determined, and the scattering S-matrix and inverse matrix are obtained. (M.J.T.)

14351 INTERMEDIATE VECTOR BOSONS AND THE MASS DIFFERENCE OF K_1^0 AND K_2^0 MESONS. V. I. Kushtan (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 136-9(1964). (In Russian)

A scheme of weak interactions with two intermediate vector bosons is presented, the starting point for construction of which is the principle of invariance in relation to the inversion of each binding constant. It is shown that, for such a formulation of weak interactions, the required value of the mass difference of the K_1^0 and K_2^0 mesons can be obtained even in the presence of currents with $\Delta Q/\Delta S = -1$. (tr-auth)

14352 DYNAMIC MODEL FOR ELEMENTARY PARTICLES. Yu. M. Loskutov and L. de la Penya Auerbakh (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 140-9(1964). (In Russian)

Systematics of baryons and mesons are considered on the basis of the dynamic model of elementary particles in the usual space-time. The mass spectra of baryons and mesons, the magnetic moments of baryons, and the internal P'-parity are obtained in the static approximation. Decay processes are analyzed. (tr-auth)

14353 FORMATION OF ELECTRON-POSITRON PAIRS IN PROTON-ANTIPROTON COLLISIONS. I. G. Dzhafarov (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 160-4(1964). (In Russian)

A study is made on the formation of polarized electron-positron pairs in collisions of longitudinally polarized beams of protons and antiprotons, taking into consideration the form factors of all the participating particles. Formulas are obtained for the differential and total cross sections and also for the degree of longitudinal polarization of the emitted pairs, and an analysis of the effects of the form factors on them is carried out. It is shown that the experimental detection of electron-positron pairs with spin correlation $a_{e^-e^+} = 1$ is a criterion of the existence of an anomalous magnetic structure in the electron. (tr-auth)

14354 FORMATION OF K-MESON PAIR IN PION INTERACTION WITH NUCLEON. A. S. Zhukarev (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 165-71(1964). (In Russian)

The pole approximation is used to study the reaction $\pi + N \rightarrow K + \overline{K} + N$ and to find the corrections which reflect the role of the central collision. Kinematics, the choice of amplitudes, and unitarity conditions are discussed. The dispersion relation for the amplitude is derived and developed to fulfil the condition of analytic continuation on physical values of the cross section. The differential cross section of the interaction is calculated. (M.J.T.)

14355 ON POLARIZATION PHENOMENA IN HIGH-ENERGY ELECTRON SCATTERING BY PROTONS. B. K. Kerimov and Ram Takvale (Moscow State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 172-80(1964). (In Russian)

Elastic scattering of high-energy electrons on protons is studied in the one-photon approximation, taking into consideration the correlation polarization among all the particles participating in the process. The variations of the e-p scattering cross section with the condition of polarization of the initial and final particles are studied. Expressions are obtained defining the angular and energy dependence of the degree of longitudinal polarization of the scattered electrons and recoil protons. (tr-auth)

14356 POSITRON ANNIHILATION IN LIQUID CRYSTALS. George D. Cole and William W. Walker (Univ. of Alabama, University). J. Chem. Phys., 42: 1692-4(Mar. 1, 1965).

Positron lifetimes were measured, as a function of temperature, in the following liquid crystalline substances: cholesterol benzoate, cholesterol sterate, cholesterol myristate, and p-azoxyanisole. The value of τ_2 was observed to vary at the melting pont of each compound and at smectic transitions. No change in τ_2 occurred at nematic isotropic and cholesteric isotropic transitions. Possible explanations for the behavior of τ_2 are suggested. (auth)

14357 ANALYTIC CONTINUATION OF a(l,s) FOR Re l < N. Robert L. Zimmerman (Univ. of Washington, Seattle and Univ. of California, Livermore). J. Math. Phys. (N. Y.), 6: 182-92(Feb. 1965).

The positions of the singularities of the partial-wave amplitude in the complex l plane are investigated for that case of a relativistic, two-particle elastic scattering amplitude satisfying the Mandelstam representation. For a finite number of intermediate states, it is shown that the convex hull of singularities in the l plane is related to a growth indicator function. For an infinite number of intermediate states, it is demonstrated that the imaginary parts of the singularities in the l plane are unbounded from either above or below. (auth)

14358 USE OF ANALYTIC SIGNALS IN THIRD- AND FOURTH-ORDER COHERENCE FUNCTIONS. M. Beran and P. Corson (Univ. of Pennsylvania, Philadelphia). J. Math. Phys. (N. Y.), 6: 271-82(Feb. 1965).

Complex forms of the third- and fourth-order coherence functions are defined using analytic signals. The relations between the complex forms and the real forms are given in detail. It is shown how to use the complex forms in the solution of radiation problems. The quasimonochromatic approximation greatly simplifies the calculations, and this simplification is discussed for radiation problems in terms of the complex forms. Quasimonochromatic radiation from a modulated incoherent source representing, perhaps, a self-luminous turbulent region is also discussed. (auth)

14359 ADIABATIC PARTICLE ORBITS IN DISCONTINUOUS FIELDS. Karl Schindler (New York Univ. and Kernforschungsanlage, Julich, Ger.). J. Math. Phys., (N. Y.), 6: 313-21(Feb. 1965).

The invariance properties of the action integral $J = \oint p\, dq$ are studied for the motion of charged particles in one-dimensional electromagnetic fields. Attention is concentrated on those situations where the field gradients become large. Whereas in the case of smooth fields and finite gradients the asymptotic theory of the one-dimensional oscillator as developed by Gardner and by Lenard applies, the presence of large gradients, requires a special treatment. The present considerations are restricted to cases in which the strong field variation is confined to a small region such that the transition can be approximated by a discontinuity. It is shown that for time intervals of order $1/\epsilon$, J is an adiabatic invariant of at least order $\epsilon^{\frac{1}{2}}$, ϵ measuring the time variation of the fields. As an example, the motion of high-speed particles through a plane discontinuity is shown to be adiabatic in that sense. Consequently, the initial and the final magnetic moments differ only slightly. (auth)

14360 SHIELDING OF A FIXED CHARGE AND POSITRON ANNIHILATION IN METALS. F. Brouers and A. Lucas (Universite, Liege). J. Phys. Soc. Japan, 19: 2351 (Dec. 1964).

The displaced charge density induced in aluminum and sodium by a fixed charge +e was calculated. The results obtained were used to evaluate the mean lifetime of the positron in these two metals. Since the positron is thermalized in a much shorter time than its mean lifetime, it may be regarded as a localized charge. (C.E.S.)

14361 A STUDY OF RESONANCES IN VIEW OF SPIN DETERMINATION. [PART] IV. G. F. Wolters. Koninkl. Ned. Akad. Wetenschap., Proc., Ser. B, 42: 220-33(1964).

The dependence of the matrix elements $\Delta^{J,J+1}_{m,m'}$ on J, M, and M' is investigated in order to gain insight in those properties of the function $\rho^J(\rho^{J+1})$ and its inverse, which are relevant for a spin determination. This function gives the correspondence between two sets of independent alignment parameters, which is present if these two sets are required to reproduce the same angular distribution. (C.E.S.)

14362 A STUDY OF RESONANCES IN VIEW OF SPIN DETERMINATION. [PART] V. G. F. Wolters. Koninkl. Ned. Akad. Wetenschap., Proc., Ser. B, 42: 234-42(1964).

Resonance disintegrations in a semiclassical picture are discussed. (C.E.S.)

14363 A STUDY OF RESONANCES IN VIEW OF SPIN DETERMINATION. PART VI. G. F. Wolters. Koninkl. Ned. Akad. Wetenschap., Proc., Ser. B, 42: 243-57(1964).

It was shown how in a [J]-dimensional vectorspace the location of a vector δ^J, describing the alignment of the resonance spin, or what is equivalent the location of a vector a^J, which can be determined from the observed angular distribution $W_J(\xi)$ for resonance disintegration, is significant for the possible exclusion of candidate spin values $J' < J$. Observation of the angular distribution is thus important for more purposes than establishing only a lower bound on the resonance spin. The main advantage of the resulting spin analysis is, that no assumptions about the resonance production mechanism are needed, which implies, that it may even be applied to a combination of samples of resonances, obtained in different experiments, provided that the isolated particle hypothesis holds. No nonrelativistic treatment of outgoing particles is required. A characteristic feature of this analysis is, that optimal statistics can be obtained. The main disadvantage of the method is, that one does not know in advance whether the resulting vector δ^J will lie in the appropriate region of δ-space. It is emphasized, that the treatment of the alignment parameters as unknowns, which can be solved from $W_J(\xi)$, allows one to obtain additional evidence for the presence of disturbing interference effects, by inspection of the behavior for $\chi \to 0$. In cases where the spin of the resonance is known, determination of the alignment parameters as functions of the production angle will allow one to study in a more detailed way the resonance production mechanism, than can be done on the sole basis of the production angular distribution, which involves a summation over all resonance spin states. (C.E.S.)

14364 THEORETICAL REMARKS ON ISOSPIN MULTIPLETS. M. Colon Vela. Koninkl. Ned. Akad. Wetenschap., Proc., Ser. B, 42: 363-6(1964).

Two results on space-time and dynamical characteristics of isospin multiplets are given. The existence of models for which the mass differences neglected between members of one isospin multiplet are not necessarily of electromagnetic origin is discussed. It is also shown that members of the same isospin multiplet do not necessarily have the same parities. (C.E.S.)

14365 ANALYTICAL PROPERTIES OF PARTIAL SCATTERING AMPLITUDES OF CHARGED PARTICLES. Yu. L. Mentkovskii (Inst. of Physics, Kiev). Nucl. Phys., 65: 673-85(Apr. 1965).

It is shown that the partial amplitudes of scattering on a nuclear Coulomb potential $S_l(k)$ are analytical functions of the momentum k in the right and left half-planes, but have a discontinuity all along the imaginary axis. A function simply related to $S_l(k)$ and having no over-all Coulomb discontinuity is found. This is important for dispersion theories. The method can be generalized for complex l. (auth)

14366 INTERACTIONS OF π^- MESONS OF 10 Gev WITH NUCLEONS. Gerda Haider. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 9, 214:-15(1964). (In German)

Ilford G5 emulsions were irradiated with mesons (π^-) at 10 Bev, and primary meson (π^-) tracks were followed. Of the 918 interactions found, 144 events could be identified as collisions of mesons (π) with nucleons. The analysis of these events gave for stars with low multiplicity, good agreement with the theoretical assumptions of peripheral interactions. Stars with high multiplicity could be traced back to collisions with the core of the nucleons. An angular distribution similar to that found for cosmic radiation was found and could be explained by the two-centers model. This distribution was, however, traced to other phenomena, such as the occurrence of peripheral interactions or the formation of resonance states. (J.S.R.)

14367 THE SOLUTION OF THE RELATIVISTIC EQUATION OF MOTION OF A CHARGED PARTICLE IN A HOMOGENEOUS MAGNETIC AND A ROTATING ELECTRIC FIELD PERPENDICULAR TO EACH OTHER. Anneke Hakkenberg and M. P. H. Weenink (FOM-Instituut voor Plasma-Fysica, Rijnhuizen, Jutphaas, Netherlands). Physica, 30: 2147-52(Dec. 1964).

The relativistic equation of motion for a charged particle in a homogeneous magnetic field and a rotating electric field perpendicular to each other was solved exactly. The expression for the orbits of a particle is given in terms of the impulse of the particle and the deviation from cyclotron resonance. Also the maximum energy a particle can gain is obtained as a function of frequency and the value of the electric field. (auth)

14368 THE PHENOMENOLOGICAL ANALYSIS FOR COLLISION CROSS SECTION AT HIGH ENERGY. D. Ito and A. Kanezawa. Soryushiron Kenkyu, 26: 8-25(1962). (In Japanese)

A phenomenological analysis of the cross section for scattering at high energy is made to determine whether the results of Regge's assumption can be obtained. The properties of the scattering matrix in the high-energy region are considered, as well as the scattering kinetics. (D.C.W.)

14369 ON THE METHOD OF DESCRIBING THE LOW-ENERGY ^{1}S N-P SCATTERING BY VIRTUAL LEVEL. Shimooke. Soryushiron Kenkyu, 26: 26-40(1962). (In Japanese)

The description of ^{1}S N-P scattering by the virtual level is considered. It is shown that the S-matrix has a zero point at $E = \omega'_p$ ($\omega'_p = \sqrt{P^2 + (M')^2}$), where P is the total momentum) on the first sheet and a pole at $E = \omega'_p$ on the second sheet and that there are no other poles. It is also shown that the scattering for ^{1}S and ^{3}S states can be described with the same coupling constant and cut-off value. (D.C.W.)

14370 ABC ANOMALY AND PI-PI INTERACTION. S. Ishida. Soryushiron Kenkyu, 26: 85-9(1962). (In Japanese)

An I = 0, S-wave π-π resonance was observed at low energy, and the Chew-Mandelstam theory was modified for π-π scattering. The results indicate that the ABC anomaly in the interaction $p-d \to {}^3He-\pi-\pi$ can be described by the new resonance. (D.C.W.)

14371 THE ELECTROMAGNETIC PROPERTIES OF FUNDAMENTAL PARTICLES IN VIGIER'S MODEL. H. Katsumori. Soryushiron Kenkyu, 26: 202-13(1962). (In Japanese)

The relations between the anomalous magnetic moments of elementary particles in Vigier's model are considered. The differences of the electromagnetic mass for baryons and mesons are discussed in terms of the mass difference produced by the electromagnetic self-energy, the electromagnetic form factor for strong interaction, and the empirical mass formula. (D.C.W.)

14372 THE RELATIVISTIC ROTATOR AND THE ELEMENTARY PARTICLE. H. Fukutome. Soryushiron Kenkyu, 26: 311-53(1962). (In Japanese)

A theory based primarily on the rotator of internal rotational motion is considered. Although the gyro-elastic particle contracting to a point does not possess size, it may be considered as a particle possessing the directional degree of freedom of linear modifiable motion and called a corpuscule. If the degree of freedom of internal motion for a corpuscule is limited to the mode of rotational motion, a rotator is thus obtained. The limit of a particle made of gyro-elastic continuum is therefore defined as a rotator. The classical motion of a rotator is considered giving firstly the Lagrange formalism and secondly the Hamilton formalism of a rotator in terms of Dirac's generalized Hamilton formalism. If, starting from the classical theory, the quantum numbers corresponding to spin, isospin, strangeness, baryon number do not exist in the classical theory as constants of motion, the rotator as the model of uniform theory for elementary, particle would have no significance. One of the purposes of this theory is, therefore, to enable the constants of motion corresponding to these quantum numbers to be obtained in the classical theory of rotator and to show that there are modes corresponding to the motion of lepton. The description of quan-

tum theory for a rotator is also considered. In the case of baryon, the above values for constants of motion can be taken as the values for the description of the baryon family. (TCO)

14373 HYPERONS AND THEIR EXCITED STATES. T. Akiba. Soryushiron Kenkyu, 26: 401-15(1963). (In Japanese)

Experimental observations on the spin of $_{\Lambda}H^{4}$, the parities of KNΣ, the properties of Y* and Ξ_0^* resonances and the $\bar{K}-N$ scattering length are discussed, together with global symmetry models of Y_1^* and the Dalitz-Tuan model of the K–N bound state. (D.C.W.)

14374 THE SIMPLE LIE GROUP IN STRONG INTERACTION. K. Kanesugi. Soryushiron Kenkyu, 26: 416-45 (1963). (In Japanese)

The theories describing the elementary particles or resonance states with the representation theory of the simple Lie group are summarized. (auth)

14375 REGGE POLOLOGY. T. Hagimoto. Soryushiron Kenkyu, 26: 446-55(1963). (In Japanese)

The angular momentum dependence of the scattering amplitude, the analytic continuation of the partial-wave amplitude, the convergent domain of the Legendre series (Lehmann ellipse) of the scattering amplitude, and the maximum value of the coupling constant are discussed in terms of the Mandelstam representation for the scattering amplitude. The method of Mellin transformation is also considered. (D.C.W.)

14376 A THEORY FOR WEAK INTERACTION. S. Matida. Soryushiron Kenkyu, 26: 456-82(1963). (In Japanese)

A uniform theory for weak interaction is presented under the assumption that the intermediate boson exists and that its interaction with current is a primary weak interaction. (D.C.W.)

14377 THE EXCITED STATES OF THE BOSON. T. Oneda. Soryushiron Kenkyu, 26: 495-503(1963). (In Japanese)

Experimental results on the production and properties of excited states of bosons are summarized, together with theoretical predictions for the branching ratios of mesons (ρ), (ω), and (η). (D.C.W.)

14378 THE NECESSITY OF 6-BODY FERMI INTERACTION. T. Katagawa. Soryushiron Kenkyu, 26: 562-4 (1963). (In Japanese)

The introduction of the 6-body Fermi interaction in order to describe the process $\Delta S/\Delta Q = 1$ in weak interaction with the Sakata model is discussed. (D.C.W.)

14379 AN APPROACH TO TAKETANI-TATI THEORY. M. Nakagawa. Soryushiron Kenkyu, 26: 565-7(1963). (In Japanese)

The mechanism of Taketani–Tati and the possibility of reconstructing strong and weak interactions in the Sakata model are studied on the basis of the field theory. (D.C.W.)

14380 ON THE MASSES OF ELEMENTARY PARTICLES. S. Nakamura. Soryushiron Kenkyu, 28: 213-22 (1963). (In Japanese)

The origin of the mass differences between Σ, Λ, Ξ, and N between meson (μ) and electrons is discussed, and an empirical relation is obtained between the mass formulas and the mass spectrum of fermions. The relation between the masses of the baryons and leptons is considered, together with the mass spectrum of mesons. (D.C.W.)

14381 THE BROKEN SYMMETRY AND SYMMETRICAL SET OF CHARGES. R. Tachi. Soryushiron Kenkyu, 28: 223-4(1963). (In Japanese)

The relation of interaction to the conservation laws of three spins is discussed with specific consideration of charge symmetry and symmetry violation. (D.C.W.)

14382 THE GENERAL THEORY OF S-MATRIX APPROACH. T. Saito. Soryushiron Kenkyu, 28: 237-71(1963). (In Japanese)

The S-matrix theory is reviewed. The general properties of the S-matrix are outlined, and the analyticity of the scattering amplitude is discussed. Potential scattering is then described with respect to the spectrum function; and the determination of the partial-wave amplitude by the N/D method is considered, together with construction of the Jost function. High-energy scattering is then discussed, with a detailed account of Froissart's theorem. The Pomeranchuk-Van Hove and Oehme theorems are also summarized. (D.C.W.)

14383 ON THE HAMILTONIAN FORMULATION OF A POINT-LIKE SYSTEM. T. Goto. Soryushiron Kenkyu, 28: 287-99(1963). (In Japanese)

A Hamiltonian formulation for a system of point-like particles is presented, in which the wave functions are irreducible representations of the Lorentz group. Application of the formulation to the rotator model of elementary particles is discussed. (D.C.W.)

14384 ON f^0-MESON IN STRONG REACTIONS. II. THE CONTRIBUTIONS TO PI-N SCATTERING. T. Inono and N. Harashige. Soryushiron Kenkyu, 28: 300-8(1963). (In Japanese)

The contribution of mesons (f^0) with I = 0 and J = 2 to $\pi-N$ scattering is investigated. (D.C.W.)

14385 THE RELATIVISTIC THEORY OF NUCLEON-NUCLEON SCATTERING. H. Ito. Soryushiron Kenkyu, 28: 330-45(1963). (In Japanese)

The validity of the Bethe-Salpeter equation in the momentum representation for N-N scattering is investigated on the basis of ladder and instantaneous approximations. (D.C.W.)

14386 THE DIRAC PARTICLES AND REARRANGEMENT SCATTERING OF COMPOUND SYSTEM. M. Akano. Soryushiron Kenkyu, 28: 346-52(1963). (In Japanese)

The rearrangement scattering of high-energy Dirac particles on a compound particle system is reviewed. The scattering matrix is written in momentum representation under the assumption that the particles of the compound system are moving in a uniform potential field and are subject to a disturbance by residual interaction. The scattering of electrons on mesons (μ^4) and nucleons at high energy is studied on the basis of the S-matrix. The cross sections are calculated, and a parameter describing the rearrangement scattering is evaluated. (D.C.W.)

14387 ON THE PROPERTIES OF SOFT CORE AND ITS ORIGIN. S. Otsuki and R. Tamagaki. Soryushiron Kenkyu, 28: 383-94(1964). (In Japanese)

The $^1S_0$ phase shift of N-N scattering can be described by a soft-core potential with a finite height. The origin and properties of the soft core are discussed. (D.C.W.)

14388 ON THE TRANSFER OF MOMENTUM IN THE NUCLEON-NUCLEON SCATTERING OF ULTRA-HIGH ENERGY. PART II. K. Kawamura. Soryushiron Kenkyu, 28: 395-400(1964). (In Japanese)

The relation between momentum transfer and the intensity of nuclear collision is studied for the case in which the two initial nucleons undergo a complex collision process and decay into two final nucleons and a secondary particle cluster. (D.C.W.)

14389 FLUCTUATION PROBLEM IN ELECTROMAGNETIC CASCADES. [PART] III. S. K. Srinivasan and K. S. S. Iyer (Indian Inst. of Tech., Madras). Z. Physik, 182; 243-56(1965).

Earlier results for the moments of the number distribution are extended to finite but very small thicknesses. These results are compared with the available experimental data in emulsions. The effect of ionization loss on the number distribution for infinite thickness is also estimated, and finally some mathematical features which establish the equivalence of the different methods of theoretical approach are dealt with. (auth)

14390 MEASUREMENT OF THE ASYMMETRY OF BREMSSTRAHLUNG OF TRANSVERSELY POLARIZED ELECTRONS. K. Guethner (Universität, Erlangen, Ger.). Z. Physik, 182: 278-88(1965). (In German)

The asymmetry of bremsstrahlung emitted from transversely polarized electrons is measured for monoenergetic electrons of 300 kev at an emission angle $\Theta = 22 \pm 20°$. The experiment yields an asymmetry $S = -(0.133 \pm 0.020) \cdot \alpha Z$ for a quantum energy of 60 to 240 kev. Exact calculations for the electron-energy used do not exist. The result is not in agreement with calculations in Born approximation. The apparatus is described, the results with all corrections are discussed. (auth)

14391 RELATIVISTIC INVARIANT DESCRIPTION OF STRUCTURED ELEMENTARY PARTICLES. Herbert Pfister (Universitat, Munich). Z. Physik, 182: 451-65 (1965). (In German)

Within a dynamic theory of fusion the three-particle-system is examined. Under suitable boundary conditions a method of integration is developed, which yields the exact solution of the relativistic three-particle-equation. This solution describes an elementary particle with internal structure. A thorough discussion of the collective motion supplies the mass M and spin $\frac{1}{2}$ for the new particle and the proper Dirac-equation, so that an identification of the three-particle-system with the electron is possible. (auth)

14392 COMPTON EFFECT IN MOVING ELECTRONS. O. F. Kulikov, Yu. Ya. Tel'nov, E. I. Filippov, and M. N. Yakimenko (Moscow State Univ. and Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1591-4 (Oct. 1964). (In Russian)

An analytical investigation of interactions between laser photons and relativistic electrons using the theory of the Compton effect showed that during head-on collisions of laser radiation (λ = 6943 Å) and relativistic electrons with an energy on the order of 500 Mev, the appearance of gamma quanta with energy about 7 Mev in the direction of electron motion should be expected. To prove this experimentally, scattered gamma radiation appearing from collision of a photon beam, generated by a ruby laser with an output pulse of 0.5 Joule, with a beam of electrons accelerated up to 600 Mev in the synchrotron was recorded. The experimental results proved the presence of Compton scattering of laser photons with an energy of 1.79 ev by relativistic electrons with an energy of 550 Mev during this head-on collision of beams. (ATD)

14393 STRANGE PARTICLE PRODUCTION BY 3 Bev/c π^- MESONS IN HYDROGEN. Thomas Patrick Wangler. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 181p.

From an analysis of 60,000 pictures of $\pi^- - p$ interactions at a pion momentum of 3 Bev/c in a hydrogen bubble chamber, over 600 events were identified as strange particle events. Reactions involving two strange particles and as many as four pions were identified on the basis of both kinematical fitting and bubble density information. The center of mass angular distributions usually show the familiar backward tendency for the baryons and a forward tendency for K mesons. Invariant mass distributions show the production of several resonant states including the Y_1^*(1385 Mev), K^*(885 Mev), and Y_0^*(1405 Mev). The two body reactions $\pi^- + p \rightarrow K^* + Y_1^*$ and $\pi^- + p \rightarrow K^* + Y_0^*$ are also reported and studied. Evidence is presented for a possible new resonance in the $K\pi\pi$ system at a mass of 1175 Mev. The two-, three-, and four-particle reactions are discussed and an attempt is made to put limits on the unitary symmetry multiplet of the f^0 from the number of $K_1^0K_1^0$ events with a mass near the f^0. The cross sections for the various reactions are calculated and the total strange particle cross section at this energy is estimated to be $\sigma = 1.682$ mb $\pm$ .199 mb. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14394 A STUDY OF ELASTIC SCATTERING OF 1.2 Bev/c MUONS FROM HYDROGEN AT LARGE MOMENTUM TRANSFERS. John Philip Toutonghi. Thesis, Seattle, Univ. of Washington, 1963. 136p.

The absolute cross section for the elastic scattering of negative muons from protons was measured over a range of momentum transfers of 450 to 850 Mev/c. The muon beam was formed by decay in flight of Bevatron-produced pions and was separated from the pion beam electronically by using four gas-filled threshold Cherenkov counters in series. A total of 3×10^8 muons was incident on two large liquid hydrogen targets in tandem and gave a total of 56 ± 9 acceptable scattering events, as compared to 48 predicted by the Rosenbluth formula for electromagnetic scattering from protons. An X-square analysis of the scattered events gave a 75% agreement between the angular distribution of the data and the theoretical predictions, and gave with 95% confidence $\Lambda^{-1} < .16$ fermi, where Λ^{-1} is the conventional breakdown parameter. Hence, in this experiment, the behavior of muons scattered from protons at large momentum transfers is indistinguishable from that of electrons. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14395 INTERACTIONS OF NEGATIVE PIONS WITH PROTONS AT 1.13 Gev/c. John Rupp Albright. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 89p.

The two-pronged interactions of negative pions at 1.13 Bev/c were studied in a hydrogen bubble chamber. There were 5414 events, of which 2363 were examples of single pion production. The most pronounced feature of these latter events is the importance of the 3-3 isobar. The data agree reasonably well with the assumption that all the single pion events involve the isobar; they suggest a model in which one of the higher isobars decays into a 3-3 and a pion. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14396 S AND P WAVE ANALYSIS OF Y_1^*(1385) PRODUCTION IN $K^- + P \rightarrow \Lambda + \pi^+ + \pi^-$ AT 760 AND 850 Mev/c. Jon Peter Berge. Thesis, Berkeley, Calif., Univ. of California, 1963. 113p.

A detailed fit of $K^- + P \rightarrow \Lambda + \pi^+ + \pi^-$ data at $P_{K^-} = 760$ Mev/c and 850 Mev/c to the Dalitz-Miller model of s- and p-wave Y_1^*(1385) production for both $J^P_{Y^*} = \frac{1}{2}^-$ and $J^P_{Y^*} = \frac{3}{2}^+$ is reported. It is found on the basis of this model that at both momenta, the $S_{\frac{3}{2}}$ decay hypothesis fits the data well, while the $P_{\frac{3}{2}}$ decay hypothesis fails to fit the data by 3 standard deviations. This result contradicts both the results of Dalitz and Miller, that from these data the Y_1^* spin hypotheses are indistinguishable, and the recent results indicating $J_{Y^*} > \frac{1}{2}$. The first contradiction is explained on grounds of the incompleteness of the original Dalitz-Miller analysis. The second contradiction seems to arise from weaknesses of the model; investigations of the model assumptions indicate that inclusion of d-wave production states would modify the fit results seriously, indicating that these results are too model-dependent to be given full credence. (Dissertation Abstr. 25: No. 4, Oct. 1964)

14397 AN EXPERIMENTAL STUDY OF THE ASSOCIATED PRODUCTION REACTION $\pi^- + p \rightarrow \Sigma^- + K^+$. Richard Robert Kofler. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 82p.

The associated production of Σ^- hyperons and K^+ mesons in $(\pi^- + p)$ interactions was studied in the Berkeley 72" liquid hydrogen bubble chamber. A beam study performed in order to obtain the total pion track length is described in detail. Corrections made to the event sample for scanning biases and detection efficiency losses are also described. The resulting cross sections at the beam momenta for which film was available were found to be: 1125 Mev/c, 218 ± 11 μb; 1225 Mev/c, 235 ± 17 μb, 1275 Mev/c, 209 ± 14 μb, 1325 Mev/c, 245 ± 21 μb. A comparison of these with previous values is made. The hyperon angular distributions at these momenta were measured. The results are consistent with S- and P-wave angular momentum states only in the production process and are characterized by more forward peaking of the hyperon at the higher momenta. A measurement of the sigma mean life, using a maximum likelihood method, yielded the value $\tau = 1.48 \pm 0.05 \times 10^{-10}$ sec. A test of the triangle inequalities required by charge independence was made by combining the Σ^-K^+ data at 1125 Mev/c with currently available data for the Σ^0K^0 and Σ^+K^+ channels at the same beam momentum. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14398 STRANGE PARTICLE DECAYS AND THE NATURE OF WEAK INTERACTIONS. Jogesh Chandra Pati. Thesis, College Park, Md., Univ. of Maryland, 1961. 293p.

An attempt is made to provide a natural explanation of the approximate validity of the $|\Delta I| = \frac{1}{2}$ rule as well as the

slowness of the leptonic modes of strange-particle decays compared to the nonleptonic ones. The simplest scheme of weak interaction, namely the Gell-Mann-Dellaporta tetrahedron scheme, which introduces the primary weak interactions only among the leptons, the nucleons, and the Λ-hyperon, is adopted. It is shown in chapter II that for $\Lambda \rightarrow N + \pi$ decays a new set of diagrams, satisfying the strict $|\Delta I| = 1/2$ rule is much more important than the usually considered diagram, which contains appreciable amount of $|\Delta I| = 3/2$ transitions in addition to $|\Delta I| = 1/2$ ones. The relative rates of the various K^+ and $K^0_{1,2}$-decay modes are estimated in chapter III with the mechanism of Λ-decay developed in chapter II both by perturbation theory and by approximate form-factor calculations. It is shown that the inclusion of the new class of diagrams for $\Lambda \rightarrow N + \pi$ decays leads to improved agreement with experiments for all the relative rates of K-meson decay modes. By including the new class of diagrams for $\Lambda \rightarrow N + \pi$ decays one can explain the previously unexplained ratios $W(K^+ \rightarrow \pi^+ + \pi^0)/W(K^0_1 \rightarrow 2\pi)$ and $W(K^+ \rightarrow \pi^0 + e^+ + \nu)/W(K^0_2 \rightarrow 2\pi)$ etc. without the introduction of final state π-π interaction; one can also explain the fact that the final state in $K^+ \rightarrow \pi^+ + \pi^- + \pi^+$ decay is predominantly symmetric between the three pions. In chapter IV the possibility that the four-fermion interactions may be mediated by a charged vector boson is examined. (A.G.W.)

14399 MOTIONS OF SPIN ONE-HALF PARTICLES. Kenneth Robert Rafanelli. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1964. 104p.

As an analog to the Dirac quantum theory for the electron, a restricted version of a classical theory proposed by Frenkel for a charged point particle with an intrinsic magnetic dipole moment is studied. The dynamical equations for the spin and trajectory, as derived from the covariant Hamiltonian formulation of both theories, are compared. The transformation properties of the classical dynamical variables are studied and strikingly similar characteristics are found for the classical variables and their quantum operator counterparts, although a fundamental difference is noted. In the few specific examples treated, the wave equation and eigenvalues resulting from a WKB quantization give agreement with the Dirac theory. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14400 SLABOE VZAIMODEISTIVIE ELEMENTARNYKH CHASTITS. (Weak Interactions of Elementary Particles). L. B. Okun. Moscow, State Publishing House of Physico-Mathematical Literature, 1963. 247p.

Systematic data are presented on weak interactions and decay of elementary particles. The hypothesis on the weak interaction universality and compound model of weak and strong interactions are extrapolated. The particles, models, interactions, LaGrangian weak interactions, lepton interactions, lepton interactions with conservation of strangeness and without conservation of strangeness, nonleptonic decay, neutral K mesons (K^0_1 and K^0_2), nonconservation of parity on nuclear forces, and weak interactions at small distances are discussed. (R,V,J.)

14401 NEITRINO. (Neutrino). M. A. Markov. Moscow, Publishing House "Nauka," 1964. 163p.

The physical phenomena of neutrino beams and weak interactions related to neutrino physics are reviewed. The singularities of four-fermion interactions, dynamic deforming form factors, two types of Dirac fields $\nu_\mu \neq \nu_e$, the intermediate boson, experiments with neutrinos using high energy accelerators or cosmic rays are discussed, as well as neutrino-lepton interactions, types of weak interactions, natural neutrino flux and cosmological problems. (R.V.J.)

14402 NONLINEAR OPTICS. A Lecture Note and Reprint Volume. N. Bloembergen. Frontiers in Physics. New York, W. A. Benjamin, Inc., 1965. 233p.

A review is presented on phenomena that occur at the light intensities available in laser beams. The harmonic generation of light, modulation of light, mixing of light waves, parametric amplification, and the coherent Brillouin and Raman effects are introduced by extending the general principles of Maxwell's electromagnetic theory and of quantum mechanics to include the high-order interactions of light and matter in terms of nonlinear susceptibilities. (D.C.W.)

Field Theory and Quantum Mechanics

Refer also to abstracts 14246 and 14383.

14403 (JINR-P-1916) STRUKTURA OBOBSHCHENNYKH FUNKTSII V LOKAL'NOI TEORII POLYA I ASIMPTOTICHESKOE POVEDENIE AMPLITUDY RASSEYANIYA. (The Structure of the Distributions in Local Field Theory and the Asymptotic Behavior of Scattering Amplitudes). Nguen Van Kheu (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 16p. Dep.(mn).

A new class of distributions which is wider than the class of tempered distributions and is suitable for formulating the microcausality principle in the local field theory is considered. It is proved that, owing to the microcausality principle and the local character of the fields, the scattering amplitudes increase slower than any linear exponential when energy tends to infinity in the complex plane. Some physical consequences of this behavior are also considered. (auth)

14404 (NYU-AA-64-2) SOME SPECULATIONS ON ELECTROMAGNETIC THEORY. H. H. Chiu (New York Univ., New York. School of Engineering and Science). July 13, 1964. 13p.

An attempt is made to derive Maxwell's equation of an electromagnetic field, in vacuo, from the relativistic Liouville's equation for the photon gas. The density distribution of the photon gas is conceived as the scalar product of two complex vector functions $\bar{\chi}$ and $\bar{\chi}^*$, which are conjugate to each other. By limiting the observation to be isotropic, it was found that half of the sum of two complex wave functions is identified as the electric field intensity, while half of the difference of the two functions, divided by $\sqrt{-1}$ is the magnetic field intensity. Two vector wave functions satisfy Maxwell's equation of the electromagnetic wave in vacuo. (auth)

14405 (TID-21309) DI-BOSON PRODUCTION BY PIONS OF 12 AND 18 Gev/C. Technical Report No. 17. L. W. Jones, (Michigan. Univ., Ann Arbor); D. Harting, W. Middelkoop, B. Zacharov (European Organization for Nuclear Research, Geneva); D. O. Caldwell (Princeton Univ., N. J.); E. Bleuler (Purdue Univ., Lafayette, Ind.); and B. Elsner (Deutsches Elektronen-Synchrotron, Hamburg). Sept. 1964. Contracts Nonr-1224(23) and AT(11-1)-917. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Di-boson production by pion interactions at 12 and 18 Bev/c with nucleons in carbon and hydrogen atoms is studied. The dibosons detected include dipions, dikaons, and resonance mesons. (T.F.H.)

14406 (UR-875-25) SOME SOLVABLE POTENTIALS FOR THE SCHROEDINGER EQUATION. H. H. Aly and R. M. Spector (Rochester, N. Y. Univ.). Mar. 13, 1964. Contract AT(30-1)-875. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Utilizing the modified Mathieu differential equation and Darboux's theorem for second order differential equations, some solvable potentials for the Schrödinger equation are constructed. The limitations of the potentials constructed by the use of Darboux's theorem are pointed out and discussed. (auth)

14407 (UCRL-Trans-1090(L)) ON THE CLUSTER EXPANSION METHOD IN QUANTUM STATISTICAL MECHANICS. Yung Tour. Translated by Chin-Wah Ma (Univ. of California Lawrence Radiation Lab., Livermore), from Wu Li Hsueh Pao, 20: 173-84(1964). 26p. Dep.(mn); $2.60(fs), $0.98(mf) JCL.

The use of the quantum-statistical cluster-expansion method for short-range interactions in fermion systems is

illustrated. The use of the method for analyzing properties of the thermodynamic potential is studied. (T.F.H.)

14408 (UCRL-Trans-1156(L)) FORMULATION OF THE LAWS OF NATURE IN TERMS OF FIVE HOMOGENEOUS COORDINATES. W. Pauli. Translated for Univ. of California Lawrence Radiation Lab., Livermore from Ann. Physik, 18: 305-72(1933). 95p. Dep.(mn); $8.60(fs), $3.05(mf) JCL.

A five-dimensional classical field theory is presented in which the projectors are homogeneously dependent on the coordinates, so that the fifth coordinate is treated in a natural manner. Representations, connections, metrics, tensor properties, and operations of this theory are studied. The theory is then used to transform the Dirac wave equations of the electron into a form in which the wave functions depend on the five homogeneous coordinates of the theory. (T.F.H.)

14409 MODEL EXPERIMENTS FOR ILLUSTRATING ELECTRON PATHS. Arpad Kiss and Ede Koltay (Lajos Kossuth Univ., Debrecen, Hungary and Inst. for Nuclear Research, Hungarian Academy of Sciences, Debrecen). Fiz. Szemle, 14: 295-305(1964). (In Hungarian)

The principles of electrons cannot be conveniently illustrated by a direct visual method; however, it is possible to carry out some simple model experiments which are helpful to determine the path of electrons in a two-dimensional electrostatic field. The so-called rubber membrane method may be even used for quantitative evaluations, within an accuracy of 10%. The two-dimensional field is mocked up by a stretched rubber membrane and conditions may be derived, under which the paths of balls moving on the curved surface (or their projection, as represented by photographic pictures) are geometrically analogous with the corresponding electron paths. The method is applicable not only to static systems but also to the representation of fields which vary as a function of time. It also presents the advantage that the field distribution and the track may be determined in a single operation. The potential ratios and the geometry of the model may be changed by changing certain field parameters. The analogy between electrons in an electrostatic field and a mass moving in a gravitational field is valid only if the latter moves without friction; of course, this condition cannot be completely fulfilled in practice. (TTT)

14410 THE STRUCTURE OF SPACE AND THE FORMALISM OF RELATIVISTIC QUANTUM THEORY. PART II. Yrjoe Ahmavaara (Univ. of Turku, Finland). J. Math. Phys. (N. Y.), 6: 220-7(Feb. 1965).

A purely group theoretical treatment of interactions of relativistic particles is shown to be possible in the connection of a finite geometry of space-time. The S operators are constructed by means of the reductions of the irreducible unitary representations of the relativity group of space-time. The dependence of the S-matrix elements on the momenta is still nontrivial, since there is a nontrivial distribution of observable momenta in a finite geometry. The Feynman graphs are easily evaluated by a simple computational technique involving five rules. The coupling schemes corresponding to nuclear, electromagnetic, and weak forces in finite geometry are considered. (auth)

14411 REDUCED DENSITY MATRICES OF QUANTUM GASES. I. LIMIT OF INFINITE VOLUME. Jean Ginibre (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 6: 238-51 (Feb. 1965).

The reduced density matrices for quantum gases are studied by Banach space techniques. For suitably restricted interactions, they are shown to be analytic functions of the activity. As the volume of the system becomes infinite, they tend in some sense to well-defined limits for which the same analyticity properties hold. As a consequence, the virial expansion is shown to be convergent in a neighborhood of the origin. (auth)

14412 REDUCED DENSITY MATRICES OF QUANTUM GASES. II. CLUSTER PROPERTY. Jean Ginibre (Univ. of Wisconsin, Madison). J. Math. Phys. (N. Y.), 6: 252-62 (Feb. 1965).

The reduced density matrices of quantum gases are studied by means of a Wiener integral representation. They are shown to satisfy a cluster property in the form of an absolute integrability condition of the natural quantum analogues of the Ursell functions, considered as functions of the differences of their arguments. Use is made of the natural transposition to the quantum case of the algebraic formalism introduced by Ruelle in the classical case. By-products are two results on the signs of the coefficients of the Mayer expansion, in the case of Maxwell-Boltzmann and Fermi-Dirac statistics, respectively. (auth)

14413 SPECIAL CLASS OF FEYNMAN INTEGRALS IN TWO-DIMENSIONAL SPACE-TIME. G. Kaellen and J. Toll (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 6: 299-303(Feb. 1965).

Contributions of Feynman diagrams consisting of a single loop with an arbitrary number of vertices are explicitly evaluated in two-dimensional space-time. The result can be written as a sum of logarithms multiplied by algebraic expressions. Each logarithm is characteristic of a simple diagram of one loop with two external lines, while the coefficients can be obtained from rules analogous to the rules of residue calculus. (auth)

14414 EXACT SOLUTIONS OF A MANY-FERMION SYSTEM AND ITS ASSOCIATED BOSON FIELD. Daniel C. Mattis and Elliott H. Lieb (International Business Machines Corp., Yorktown Heights, N. Y.). J. Math. Phys. (N. Y.), 6: 304-12(Feb. 1964).

Luttinger's exactly soluble model of a one-dimensional many-fermion system is discussed. It is shown that he did not solve his model properly because of the paradoxical fact that the density operator commutators $[\rho(p), \rho(-p')]$, which always vanish for any finite number of particles, no longer vanish in the field-theoretic limit of a filled Dirac sea. In fact the operators $\rho(p)$ define a boson field which is associated with the Fermi–Dirac field. This observation is used to solve the model and obtain the exact (and now nontrivial) spectrum, free energy, and dielectric constant. This is extended to more realistic interactions. The Fermi surface parameter is calculated. (auth)

14415 THE DIRAC EQUATION AND THE UNITARY REPRESENTATIONS OF THE INHOMOGENEOUS LORENTZ GROUP. L. B. Redei (Univ. of Edinburgh). J. Math. Phys. (N. Y.), 6: 322-(Feb. 1965).

The Dirac equation in its quantized form is discussed in order to deduce the structure of the unitary representation of the Poincaré group in Fock space. A short account of discrete symmetries in Fock space is given, and a simple method of calculating spin matrix elements is outlined. (auth)

14416 EXPERIMENTAL INVESTIGATION OF THE SECOND POSTULATE OF SPECIAL RELATIVITY. Ray O. Waddoups, W. Farrell Edwards, and John J. Merrill (Utah State Univ., Logan). J. Opt. Soc. Am., 55: 142-3(Feb. 1965).

The addition-of-velocities hypothesis, which Kantor claimed to have verified, was investigated using a different experimental arrangement. A laser beam was passed through a moving mica window, which might be considered as a Huygens-type moving source of light. An interferometer was built with which to detect and measure any change in speed of the emitted light. The apparatus allowed investigation of the effects of window speed, which could be varied continuously up to 63m/sec; direction of window motion with respect to direction of propagation; and the effects of air in the beam path. Emission theory as used by Kantor predicted a $\frac{1}{3}$ fringe shift; however, no shift was observed under any conditions. The estimated sensitivity of the method is $\frac{1}{20}$ fringe. The results are therefore consistent with the second postulate of special relativity, but not with Kantor's hypothesis. (auth)

14417 ON THE QUESTION OF UNIVERSALITY. M. Nakagawa. Soryushiron Kenkyu, 26: 552-6(1963). (In Japanese)

Universality is discussed on the basis of the G-values for meson (μ) decay of mesons (K) and (π), beta decay, and

neutrino decay. The intermediate vector boson theory and the modified Nagoya model are considered. (D.C.W.)

14418 ON THE TRUE VACUUM. K. Watanabe. Soryushiron Kenkyu, 28: 309-20(1963). (In Japanese)

The vacuum with interactions caused by the particle cloud extension is studied, using the Nambu method for dealing with Gell-Mann's true vacuum and for deriving the Bethe-Salpeter equation. (D.C.W.)

Geophysics

14419 (AFCRL-64-606(I)) ROCKET-BORNE INSTRUMENTATION TO MEASURE THE RATE OF IONIZATION AND RELATED PHENOMENA DURING AN AURORA. Final Report. Part I. W. P. Reidy, G. Davidson, R. Giacconi, O. Shepherd, and R. Smith (American Science and Engineering, Inc., Cambridge, Mass.). June 15, 1964. Contract AF19(628)-252. 103p. (ASE-531)

The scientific objectives of the experiments and the individual instruments flown on the Astrobee 200 sounding rocket AC 15.610 are discussed in detail. The rocket was instrumented for auroral studies and was launched from Fort Churchill, Manitoba, Canada, on 8 December 1963. Included in the instrument package were: a free-flow ionization chamber to measure the rate of ion production during periods of abnormally large ionization; a scintillation total-energy detector; an electron electrostatic analyzer to measure the differential electron energy spectrum from 1 to 80 kev; A proton spectrometer to measure the integral proton spectrum between 50 and 500 kev; a Geiger tube experiment to measure the soft x-ray flux and the intensity of energetic particles; and photometers which measured the intensity of selected auroral lines. (auth)

14420 (ATD-P-64-51) PHENOMENA IN THE UPPER ATMOSPHERE. Compilation of Abstracts. Report No. 48. (Library of Congress. Aerospace Technology Div., Washington, D. C.). Sept. 2, 1964. 32p. (AD-605327). $2.00(OTS).

Topics covered in this series are as follows: ionospheric electron concentrations, solar radiation and the ionosphere, Van Allen belts and cosmic rays, telluric currents, atmospheric electricity, nuclear bursts in the atmosphere, satellite and missile data, arctic and antarctic communications, and meteorology of the upper atmosphere. (auth)

14421 (NASA-TN-D-2612) DIFFUSION OF AURORAL ELECTRONS IN THE ATMOSPHERE. Kaichi Maeda (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Feb. 1965. 26p. $2.00(OTS).

The results of a Monte Carlo computer program originally written to treat electron reflection and transmission by plane-parallel slabs are applied here to the diffusion of monoenergetic auroral electrons in the polar atmosphere. The following conclusions are reached: The straggling effect is significant for electrons with energies above 20 kev, but is negligible below 10 kev. Back-scattering decreases at both high and low energy levels, showing a maximum around 20 kev. The back-scattering coefficient at the maximum level is on the order of 7% (intensity) and 4% (energy flux) for vertical incidence, and 20% and 15% respectively, for isotropic incidence. Angular distribution of penetrating electrons approaches perfect diffusion with cosine-squared rather than Gaussian distribution around half of the penetration (back-diffusion) depth for both vertical and isotropic incident distribution. Also, previous calculations on penetration depth and effective depth of energy distribution are shown to have been greatly underestimated for electron energies above 20 kev, because of the straggling effect. (auth)

14422 (RM-65TMP-4) A THEORY OF COMPRESSIBLE VISCOUS FLOW WITH APPLICATIONS TO LATE-TIME FIREBALL MIXING. J. W. McKee and C. L. Dolph (General Electric Co. Technical Military Planning Operation, Santa Barbara, Calif.). Jan. 1965. Contract AF19-(628)-4210. 72p. (AFCRL-65-48)

A technique is described for the solution of a class of problems in compressible turbulent flow, and its application to a problem involving the rise and the entrainment of ambient air by the late-time fireball due to a nuclear detonation in the atmosphere is demonstrated. The method is based on the result that the components of Fourier spectra of velocity parallel to the wave vector are associated with compression waves (irrotational flow), while those components transverse to the wave vector are associated with eddy turbulence. If solutions are sought for systems in pressure equilibrium with an undisturbed atmosphere, the resulting formalism takes on considerable simplicity, owing to uncoupling of the equations of motion. Assumptions related to the evaluation of certain convolution integrals that appear in the theory are examined and shown to involve the largest eddies in the role of the principal convective agent. This assumption converts the nonlinear Navier-Stokes equation to linear form. The heat transfer and continuity equations are also simplified by the same linearization process. Simultaneous solutions of the equations in wave-vector space and subsequent inversion to physical space with certain initial conditions provides solutions that have considerable similarity to the actual flow situation found in weapons tests such as vortex ring (torus) formation. Qualitative and quantitative features of the predicted motion, for example, velocity distribution, rise rate, and temperature, are discussed. (auth)

14423 (TG-230-B5) GEOPHYSICAL EFFECTS OF HIGH-ALTITUDE NUCLEAR EXPLOSIONS OF 1962. An Annotated Bibliography. Edmund J. Blau (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Oct. 1, 1964. 39p. (AD-607982). $2.00(OTS).

A total of 193 references is presented on geophysical effects produced by American and Soviet shots in 1962. The American shots include those on July 9, Oct. 20 and 26, and Nov. 1 and 4, while the Soviet shots were those of Oct. 22 and 28 and Nov. 1. Emphasis is placed on the Starfish test of July 9. (D.L.C.)

14424 PROCEEDINGS OF THE CONFERENCE ON ARTIFICIAL SATELLITES, AUGUST 12 THROUGH AUGUST 16, 1963. Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser., 57: No. 8, Pt. A, 173p.(Aug. 1964). (CONF-630801)

Separate abstracts were prepared for three of the ten papers included. The remaining papers deal with the earth's atmosphere, the Van Allen radiation belts, space, meteorites, and geodetic information and implications. (D.C.W.)

For abstracts of individual papers see: 14277, 14425, and 14426.

14425 IONOSPHERE. Robert E. Bourdeau (Goddard Space Flight Center, Greenbelt, Md.). Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser., 57: No. 8, Pt. A, VIII1-21(Aug. 1964).

The results of some rocket and satellite measurements on the charged particle densities, ionization, electron temperatures, composition, temperature, and electron collision frequencies of the ionosphere are discussed with consideration of associated theory. 63 references. (D.C.W.)

14426 GEOMAGNETISM AND THE IONOSPHERE. E. H. Vestine and J. W. Kern (RAND Corp., Santa Monica, Calif.). Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser., 57: No. 8, Pt. A, VIII1-22(Aug. 1964).

The geometry of the magnetosphere and the dynamics of energetic particles and plasmas trapped within it are discussed in relation to some problems of geomagnetism. Local acceleration of trapped particles is discussed, and the possible origins of electric fields and their role in this and other magnetospheric phenomena are noted. It is found that many interesting phenomena can be re-interpreted in terms of the original Chapman-Ferrars theory of geomagnetic storms. 85 references. (auth)

14427 GEOMAGNETIC EFFECTS ASSOCIATED WITH THE HIGH-ALTITUDE NUCLEAR EXPLOSION. Y. Yamaguchi. Chijiki Kansokujo Yoho, 11: 1, 53-64(1963).

The effects of the nuclear explosion on July 9, 1962 near

Johnston Island on the geomagnetic field are described, and the mechanism of this disturbance is discussed in terms of the dynamo theory. The enhancement of the electric conductivity of the ionosphere is estimated, and preliminary observations of the effects of the Nov. 1962 tests are included. (D.C.W.)

14428 GEOMAGNETIC EFFECTS ASSOCIATED WITH THE HIGH-ALTITUDE NUCLEAR EXPLOSION— SUPPLEMENTARY NOTE. Y. Yamaguchi. Chijiki Kansokujo Yoho, 11: No. 2, 23-37(1964).

The enhancement of the electric conductivity of the ionosphere resulting from the nuclear explosion on July 9, 1962 near Johnston Island is recalculated on the basis of the dynamo theory, considering the diurnal component of the wind as well as the semi-diurnal irrotational wind component. (D.C.W.)

14429 A SMOOTH TYPE OF COSMIC NOISE ABSORPTION. J. Ortner and W. Riedler (Kiruna Geophysical Observatory, Kiruna, Sweden). Nature, 204: 1181-2 (Dec. 19, 1964).

Data from riometer investigations of auroral absorption events are examined. The events analyzed did not occur during magnetically quiet periods. It was found that smooth absorption events can be observed only at stations situated in or near the auroral zone. It is concluded that smooth events should be considered as belonging to the group of auroral-type absorptions caused by precipitation of energetic electrons. (J.R.D.)

14430 EARTH'S RADIATION ENVIRONMENT. Wilmot N. Hess (Goddard Space Flight Center, Greenbelt, Md.). Space/Aeron., 42: No. 6, 68-76(Nov. 1964).

The effects of solar magnetic fields and radiation on the earth's magnetic fields and radiation environment are discussed. The distribution and origin of particles in the radiation belts, radiation belts on other planets, and the implications for space travel are considered. (D.C.W.)

14431 GEOMAGNETIC STORMS, AURORAS, AND ASSOCIATED EFFECTS. J. H. Piddington (Commonwealth Scientific and Industrial Research Organization, Sydney). Space Sci. Rev., 3: 724-80(Dec. 1964).

The knowledge of the interplanetary medium is outlined and its frictionless interaction with the geomagnetic cavity, first discussed by Chapman and Ferraro, is described. An important feature of this interaction is the interplanetary field which is compressed and may possibly lead to the formation of a shock wave. The possibility of frictional interaction between the solar wind and the cavity is discussed; an effect which appears to cause friction is the instability of interpenetrating ion-electron streams. This effect will also cause strong heating and trapping of ions and the generation of electromagnetic waves. The theory of propagation of geomagnetic disturbances in the magnetosphere and ionosphere is reviewed, first in general terms and then for some of the various components of a geomagnetic storm. Sea-level disturbances are divided into stormtime (Dst) and other (DS) components and also into different phases and the experimental data are reviewed. Theories of Dst, including the ring-current theory and magnetic tail theory are discussed and compared. Attempts to explain the complex DS field comprise the magnetospheric dynamo theory and the asymmetrical ring-current theory; these are compared in the light of experimental evidence. Motions of plasma and field lines in the magnetosphere are discussed in general terms: there are motions which deform the field and there are interchange motions. The former are opposed by Earth currents; the latter are not. The two types of motion are coupled through ionospheric Hall conductivity. Theories of the DS field in terms of the two types of motion are described; in particular motions caused by frictional interaction with solar wind are discussed. These motions cause a helical twist in the field lines which propagates into the polar ionosphere as a hydromagnetic wave. In the ionosphere the motions of the field lines drive currents (moving-field dynamo) which cause the DS field. Drifts of neutral ionization in the lower ionosphere lead to localize accumulations which play a vital part in storm and auroral theory: they cause polarization fields which change the DS current system; they react on the magnetospheric motions to cause particle acceleration and precipitation. Auroral morphology and theories are briefly reviewed; the solar wind friction theory, although far from complete may provide a start. Further development should take the form of determining ionospheric drifts, polarization electric fields, and consequent magnetospheric effects. A brief discussion is given of some associated effects: growth and decay of belts of geomagnetically trapped corpuscules; increase in ionospheric absorption of radio waves and lower-level x-ray production, ionospheric storm and high-latitude irregularities, micropulsations, VLF and ELF radio emissions from the magnetosphere, atmospheric heating, and wave generation. (auth)

14432 GEO-I GELIOFIZICHESKIE EFFEKTY V KOSMICHESKIKH LUCHAKH I POLYARNYKH SIYANIYAKH. (Geo- and Heliophysical Effects in Cosmic Rays and Aurora Polaris). Yu. G. Shafer, ed. Moscow, Izdatel'stvo "Nauka," 1964. 157p.

Twenty-three articles are included on geophysical and heliogeophysical effects in cosmic radiation and aurora polaris. The basic characteristics of Forbush effects, cosmic ray intensity variations in the stratosphere, cosmic ray variations during 1958–60, meteorological effects of cosmic rays during magnetic storms and cyclones are discussed. Spatial distribution of aurora polaris, properties of spectral chambers for measuring aurora brightness, and photographic techniques are analyzed. (R.V.J.)

Low Temperature Physics

Refer also to abstracts 13566 and 14650.

14433 (CONF-651-44) MAGNETOTHERMAL EFFECTS IN TYPE II SUPERCONDUCTORS. N. H. Zebouni, A. Venkataram, G. N. Rao, C. G. Grenier, and J. M. Reynolds (Louisiana State Univ., Baton Rouge). [1964]. Contract [AT(40-1)-3087]. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Magnetothermal effects, observed in massive rods of pure Nb and of Nb-31% Zr with magnetic field directions both parallel and perpendicular to the axis of the rods, are described. These effects are directly related to the detailed structure of the flux penetration mechanism and to the existence of collective modes of vibration of the Abrikosov vortices. (C.E.S.)

14434 (LNF-64/50) PROPOSTA DI UN NUOVO SISTEMA PER INDURRE CORRENTI PERSISTENTI IN UN ANGELLO SUPERCONDUTTORE. (Proposal of a New System to Induce Persistent Currents in a Super-Conducting Ring). Note No. 261. C. Guaraldo, G. Sacerdoti, and A. Susanna (Italy. Comitato Nationale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Oct. 10, 1964. 8p. Dep.(mn).

A mechanism to induce persistent currents in a superconducting ring is proposed. The currents are induced by a circularly polarized electromagnetic wave that is propagated in a circular guide. The experimental apparatus, theoretical considerations on the mechanism, and numerical calculations of the theory are described. (J.S.R.)

14435 (NP-14676) A RESEARCH INVESTIGATION OF THE FACTORS THAT AFFECT THE SUPERCONDUCTING PROPERTIES OF MATERIALS. Progress Report No. 3, June 15–December 15, 1964. R. W. Schmitt, C. P. Bean, P. S. Swartz, J. D. Livingston, H. R. Hart, Jr., T. A. Buchhold, and P. J. Molenda (General Electric Co. Research Lab., Schenectady, N. Y.). Contract AF33(657)-11722. 54p.

Fundamental studies of superconductive properties that are important for their use in coils and electrical equipment (critical currents, a-c losses, and flux jumping) are reported. The critical current density of materials can be measured magnetically even in the presence of flux jumps

by employing an a-c harmonic analysis technique. Using the technique, measurements of the critical current density vs applied field are made on samples of intermetallic, high-field superconductors. Among the materials studied are ones with critical currents that were enhanced by radiation damage. A particularly effective way of damaging intermetallics is to add fissionable impurities to the material and subsequently to irradiate them with thermal neutrons. A brief description is given of new studies that are being undertaken of flux jumps and of the interaction between imperfections and fluxons. Studies of the low-frequency, low-field a-c losses in niobium were continued and new results obtained. Surface effects in the mixed superconducting state are also discussed. (auth)

14436 (NYO-2391-1) TUNNELING BETWEEN SUPERCONDUCTORS—THE JOSEPHSON EFFECT (thesis). Report No. 256. Alexis Baratoff (Cornell Univ., Ithaca, N. Y. Materials Science Center). Sept. 1964. Contract AT(30-1)-2391. 145p. Dep.(mn); $4.00(cy), 3(mn) OTS.

The effects of impurities on the zero-voltage tunneling supercurrent in N–I–S and S–I–S sandwiches (where N is normal metal, I an insulator, and S a superconductor) are studied. The theoretical results are compared with experimental observations for Sn–Pb, Sn–Sn and In(Fe)–Al, S–I–S and N–I–S sandwiches. (T.F.H.)

14437 A NEW PRINCIPLE FOR THE CONSTRUCTION OF STABILIZED SUPERCONDUCTING COILS. A. R. Kantrowitz and Z. J. J. Stekly (Avco Corp., Everett, Mass.). Appl. Phys. Letters, 6: 56-7(Feb. 1, 1965).

A completely stabilized superconducting coil was constructed of Nb–25% Zr wire embedded in Cu which was maintained at 4.2°K by exposure to liquid He. The current at which voltage first appeared was 710 amp, and the central field was 38 kgauss. (D.C.W.)

14438 DISCONTINUITY OF THE CRITICAL a-c CURRENT VALUE IN PASSING THROUGH THE LAMBDA-POINT OF A SUPERCONDUCTING SOLENOID. V. V. Sychev, V. B. Zenkevich, V. V. Andrianov, V. A. Al'tov. Dokl. Akad. Nauk SSSR, 159: 60-2(Nov. 1, 1964). (In Russian)

The factors determining the critical current value in superconducting solenoids were studied experimentally by establishing the behavior of the critical current value as the temperature was reduced. Network power at a frequency of 50 cps was used in measurements. The coils were made of 65 BT (a multi-component Nb–Ti-based alloy) superconducting wire 0.25 mm in diameter, viniflex coated to a diameter of 0.30 mm. The experimental arrangement permitted lowering the temperatures in the cryostat to 2°K by reducing the helium vapor pressure in the chamber. Three types of solenoids were investigated. Type I had 6200 turns with inside and outside diameters of 16 and 45 mm respectively, and a coil height of 35 mm. The value of the critical current density remained constant in this solenoid, down to a temperature of about 2.17°K where a sharp upward jump occurred. The solenoids of types II and III were wound on a polyfluoroethylene form of 55 mm high and having an axial hole of 6 mm in diameter. Solenoid II had 5000 turns, its inside and outside diameters were 16 and 39 mm, and it was 35 mm high. Solenoid III had 2700 turns, inside and outside diameters of 16 and 29 mm, and a height of 35 mm. The measurements revealed that the value of critical current density rises sharply with smaller solenoids. The results obtained point to a strong dependence of the critical current value on the penetration of the liquid helium into the inner zone of the winding. Helium vapors in that zone apparently do not prevent the inflow of the liquid. In any case, the results obtained cannot be satisfactorily explained solely by changes in heat conduction from the surface of the solenoid during the transition through the lambda point. (ATD)

14439 MICROSCOPIC THEORY OF MAGNETIC FLUX QUANTIZATION IN SUPERCONDUCTORS. L. P. Rapoport (Voronezh State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 58-63(1964). (In Russian)

A microscopic theory of quantization of the magnetic flux through superconducting cylinders is developed. The connection of this phenomenon with quantized vortices in systems of fermions is demonstrated. (tr-auth)

14440 A SUPERCONDUCTING TRANSFORMER. B. B. Goodman (Centre National de la Recherche Scientifique, Grenoble, France). J. Phys., Phys. Appl. (Paris), 25: 171A-2A(Nov. 1964). (In French)

It is shown that a superconducting transformers would be much more compact than a conventional transformer with the same power rating. The losses arising from the use of a superconducting wire in the mixed state are then studied. (D.C.W.)

14441 THERMODYNAMIC PROPERTIES OF ^{3}He AND ^{4}He SOLUTIONS. III. A REFINEMENT IN EXCESS FUNCTIONS ABOVE THE SUPERFLUID TRANSITION IN SOLUTION. V. S. Nanda and R. Chandra (Univ. of Delhi). Phys. Fluids, 8: 242-4(Feb. 1965)

A semiclassical approach to the problem of ^{3}He and ^{4}He solutions for temperatures above the superfluid transition in solution was previously presented by Chandra and Nanda. The question of a proper choice of the nonideality parameter is now considered. A satisfactory representation of the excess chemical potentials, excess enthalpy, and excess entropy is thus obtained. The contributions of the like and unlike pairs to the cohesion in the solution are also compared. (auth)

14442 THE HEAT CONDUCTIVITY OF ^{3}He AND ^{4}He AND THEIR MIXTURES IN THE GASEOUS STATE BETWEEN 0.5 AND 3°K. K. Fokkens, W. Vermeer, K. W. Taconis, and R. De Bruyn Ouboter (Kamerlingh Onnes Laboratorium, Leiden). Physica, 30: 2153-74(Dec. 1964).

The thermal conductivity coefficient of gaseous ^{3}He, ^{4}He and a 50% ^{3}He-^{4}He mixture was measured between 0.5 and 3°K. The apparatus consisted of two parallel horizontal plates with a shield ring around the upper plate. The distance between the plates is variable. Several methods for measuring the conductivity are discussed. The results are compared with theoretical calculations of the transport properties of the helium isotopes by De Boer, Keller, Buckingham and Scriven. In general, satisfactory agreement is found. (auth)

14443 ON MAGNETIC TRANSITIONS OF DIFFERENT ORDER, IN PARTICULAR CONCERNING SUPERCONDUCTORS, NEAR THE H- AND T-AXES. C. J. Gorter (Kamerlingh Onnes Laboratorium, Leiden). Physica, 30: 2175-9(Dec. 1964).

It is argued on thermodynamical grounds that in general magnetic transition lines must meet the T- and H-axes under right angles. Exceptions may occur if the transition terminates at the axis in a transition point of higher order or if more than one line meets in a point at the axis. Attention is called to the mysterious character of the entropy over temperature near a second order superconductive transition line at very low temperature. (auth)

14444 ON THE PROBLEM OF SURFACE SUPERCONDUCTIVITY. V. L. Ginzburg (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 2318-20(Dec. 1964). (In Russian)

The possibility of developing surface superconductivity (even at high critical transition temperatures T_c) by creating an additional attraction between the electrons by cooling the surface with a dielectric film or molecular layer of neutral atoms is discussed. (R.V.J.)

14445 A COMPARATIVE STUDY OF FLUX TRAPPING IN SUPERCONDUCTING TIN, LEAD AND NIOBIUM CRYSTAL SPHERES. Keith James Carroll. Thesis, Houston, Tex., Rice Univ., 1964. 102p.

A comparison is made of the flux trapping properties of tin, lead, and niobium single crystal spheres about one cm in diameter. The spheres were used as the bob on a torsion pendulum, with a fine tungsten wire serving as the torsion fiber. The spheres were taken into the superconducting region in a magnetic field, so that they passed through an intermediate state, which gave them an opportunity to trap

some percentage of the flux present in them in the normal state. As a result, the superconducting sphere was left with a permanent magnetic moment M. Measurements were made for a variety of ways of entering the superconducting region—at constant field, at constant temperature, for varying speeds of transition, while rotating the sphere at constant speed, etc. Results so far show that the trapped flux in tin is very small (0.05%) except near T_c, where it rises sharply. For lead, the value is somewhat larger, rising to over 2% at the largest field available (475 gauss). In niobium, the percentage of trapped flux is about half as large as in lead and decreases slightly as the field transition goes from about 200 to 450 gauss. In all cases, the magnetic moment may vary with T in the superconducting region, but there is no tendency for the trapped flux to leak out if T is held constant. The flux trapping in the tin sphere is highly preferential, the magnetic moment in some cases being at right angles to the direction of the applied field, and rotation of the niobium and lead spheres while passing through the intermediate state causes a sharp drop in M even for low rotational speeds (~5 rpm). The results are interpreted in terms of the anisotropic properties of crystalline tin and a distribution of flaws likely to be present in the specimens. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14446 CURRENT-INDUCED SWITCHING IN THIN-FILM SUPERCONDUCTING CIRCUITS: AN ANALYSIS OF ELECTRICAL AND THERMAL TRANSIENTS IN THE PERSISTATRON. Wilber Clarence Stewart. Thesis, Durham, N. C., Duke Univ., 1964. 133p.

The persistatron, a persistent-current switching and memory circuit invented by M. J. Buckingham and W. M. Fairbank in 1958, is studied. Of particular interest is the effect of the current-induced transition in thin Pb films on device characteristics. Experimental circuits are fabricated by depositing vacuum-evaporated Pb upon glass substrates through interchangeable masks. A lumped-parameter equivalent circuit utilizing inductance and resistance is derived from Maxwell's equations and London's equations in the low frequency limit. Expressions for inductance consistent with magnetic free energy considerations are formulated explicitly from relations for total external magnetic flux, partial flux linkages in the normal conductors, and a term proportional to the line integral of surface current density in the superconductors. An equivalent circuit for the conductively-coupled persistatron, under a suitable transformation of independent variables, is identical to that proposed by other investigators for the inductively-coupled Crowe cell. Experiments performed for the study of current-induced transitions in thin Pb films from 400 Å to 1000 Å thick provide information about the resistance variation in persistatron critical elements. Thermal propagation effects and substrate heating are included in the persistatron equivalent circuit by assuming that resistance increases at a uniform rate when current exceeds a critical value, and that it diminishes at a lesser rate after current drops below a fixed fraction of the original critical current level. Both steady-state and priming pulse responses are calculated for the cases of four particular operating modes: pure thermal propagation for all drive current amplitudes, resistance saturation during switching, vanishingly small propagation times, and for long thermal recovery times. The analysis shows that a reduction in circuit operating range caused by thermal propagation effects can be partially offset by substrate heating. In addition, predictable conditions exist for which a range of steady drive pulse amplitudes produce unsteady circuit operation. (A.G.W.)

14447 CRITICAL TEMPERATURES AND CRITICAL FIELDS OF MULTIPLE SUPERCONDUCTING AND NORMAL CONDUCTING FILMS. Richard James Duffy. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1964. 129p.

The critical temperatures and critical fields were measured for sets of multiple superconducting and normal conducting films. Measurements on evaporated Sn–Au and Sn–Cu samples were made between 0.8°K and 4.2°K. Each set of samples, having a constant Sn thickness and a variable amount of normal metal, was made at the same time. The Sn thickness ranged from 160 to 2700 Å. The Cu and Au thicknesses ranged from 25 to 2000 Å. Great care was taken to maintain diffusion effects constant for all samples. Positive evidence is given for a proximity effect in Au–Sn. The factors influencing the critical fields and the critical temperatures are discussed. (Dissertation Abstr., 25, No. 4, Oct. 1964)

14448 THE SURFACE IMPEDANCE AT 9 KILOMEGACYCLES OF NORMAL CONDUCTING FILMS DEPOSITED ONTO SUPERCONDUCTING SUBSTRATES. Robert Vincent Fanelli. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1964. 104p.

Measurements of the microwave absorption at 9.2 kMc were made on samples consisting of gold or copper films electroplated onto bulk tin. The measuring technique used a calorimetric technique due to Fawcett. The object of the experiment was to look for evidence for an energy gap in the normal conducting films due to a proximity effect. No clear evidence for such a gap was found for the gold films. Evidence for a gap in the copper films which exceeds 3.75×10^{-4} ev for films less than 700Å thick is presented. These results are discussed in the light of other experiments and present theories. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14449 SUPERCONDUCTIVITY IN THIN FILMS. Ram Das Chaudhari. Thesis, Vancouver, Can., Univ. of British Columbia, 1964. 124p.

Experiments on destruction of superconductivity by electric currents and magnetic fields in films of indium and tin of varying thickness are described. The indium films in the thickness range of 585 to 3540Å were deposited on sapphire rods at liquid nitrogen temperature in vacuum better than 10^{-5} mm of Hg. Only two tin films, 910 and 3250 Å in thickness deposited at room temperature on sapphire rods, were examined. All the measurements were made in the temperature region $0 \leq \Delta T \leq 0.4$°K where $\Delta T = T_c - T$. The critical current measurements on a 585 Å thick indium film were made by combining the use of a compensated geometry and fast rising current pulses. The current pulses used had a rise time of 7 nano seconds. For a number of indium films, the critical currents were measured by using pulses having a rise time of 1.2 micro seconds. The critical currents were found to vary linearly with the film thickness, in agreement with G–L theory. Measurements with fast pulses seem to indicate the existence of a transition delay of 6 nano seconds, independent of current amplitudes. The transition from the superconducting to the normal state, immediately following the transition delay, appears to be extremely fast. For the critical field data, the temperature dependence is in accordance with G–L theory in the range $0 \leq \Delta T \leq 0.3$°K for both indium and tin films. The effective penetration depth calculated in the manner of Ittner, and Douglass and Blumberg was found to be dependent on thickness and mean free path. The critical magnetic fields were found to be inversely proportional to the film thickness in agreement with G–L theory. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14450 EFFECT OF A STATIC MAGNETIC FIELD ON MILLIMETER WAVE ABSORPTION IN SUPERCONDUCTING ALUMINUM. W. V. Budzinski and M. P. Garfunkel (Univ. of Pittsburgh). 10p. (CONF-651-77)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

An experimental study was made of the effect of a static magnetic field on the surface resistance ratio R/R_n (R, R_n = real parts of surface impedance in superconducting and normal states) of Al for photon energies of 1 to 4 kT_c and for reduced temperatures T/T_c between 0.3 and 1.0. The results are expressed as functions of field, temperature, and frequency. Shifts in superconducting energy gaps are discussed. (D.L.C.)

14451 HEAT TRANSPORT BY HELIUM II THROUGH SMALL CAPILLARIES. H. H. Madden, R. H. Hammerle, and H. V. Bohm (Wayne State Univ., Detroit). 8p. (CONF-651-80)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Experiments were conducted to detect nonlinearity in the

thermal conductivity of liquid He II determined by means of capillary bundles. The temperature range was from 1.520 to 2.055°K, and deviations from linearity of the heat current vs temperature difference curves appeared only above 2°K and with the 3-cm length assembly. The difference between the thermal conductivity curves for the 3- and 6-cm assemblies may be due to a length effect or to a difference in the average diameters of the capillaries. The thermal conductivity curves are compared with a theoretical curve normalized at 2.0°K. Data using a 9-cm assembly also indicate a length effect. (D.L.C.)

14452 AN INVESTIGATION OF THE NATURE OF THE SPECIFIC HEAT IN THE NEIGHBORHOOD OF THE CRITICAL POINT OF He^4. M. Moldover and W. A. Little (Stanford Univ., Calif.). 9p. (CONF-651-49)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The specific heat at constant volume C_v of ^4He was studied at densities close to the critical density to see if the logarithmic singularity observed for argon is also exhibited by He. For temperatures above and below T_c, C_v follows a logarithmic behavior, with deviations from this behavior close to T_c. At densities other than the critical density, the C_v vs T curve differs from that for the critical density; at some temperature below T_c, C_v falls abruptly. (D.L.C.)

14453 THE ISOTHERMAL HELIUM FILM BELOW 1°K. C. F. Mate, R. Harris-Lowe, and J. G. Daunt (Ohio State Univ., Columbus). 8p. (CONF-651-78)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The film transfer rate σ (cm^2/sec) was measured in a glass beaker at temperatures from the lambda point to 0.35°K. The results above 1.2°K agree with previous measurements, but below 1.2°K the rate rises sharply so that a "knee" is formed in the curve at 1.15 ± 0.05°K. The data scatter is also increased at the lower temperatures. Further experiments suggest that $d\sigma/dT = 0$ at 0°K. A marked dependence of transfer rate on film height was found at 0.6°K but not at 1.3°K. The possible reasons for the height dependence and data scatter are discussed. (D.L.C.)

14454 ON THE LINE WIDTH OF COLD NEUTRONS SCATTERED BY HELIUM II. S. Franchetti (Università di Firenze, Italy). 10p. (CONF-651-73)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

An explanation is presented of why neutrons scattered by liquid He II show a width much larger than that predicted by Landau-Khalatnikov theory using the finite lifetime of roton states. The explanation is based on the use of one-particle eigenfunctions to describe fundamental and roton states and on the formal similarity of the structure of these eigenfunctions to that of ordinary monatomic liquids. (D.L.C.)

14455 THERMOHYDRODYNAMIC FLOW SIMILARITY OF He II IN WIDE CHANNELS AT SUPERCRITICAL VELOCITIES. T. H. K. Frederking and J. D. Schweikle (Univ. of California, Los Angeles). 8p. (CONF-651-79)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

He II turbulence in wide channels was studied to investigate the similarity of He II behavior to ordinary fluid phenomena. Experiments on isothermal gravitational flow in channels with rough walls were carried out, and the hydrodynamic results were used to obtain some insight into heat transport phenomena for the special case of zero net flow of mass. (D.L.C.)

14456 EFFECT OF MAGNETIC FIELD ON MILLIMETER WAVE ABSORPTION IN SUPERCONDUCTING ALUMINUM. Walter Valerian Budzinski (Univ. of Pittsburgh). 56p. (CONF-651-76)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Experiments were conducted to study the feasibility of using a calorimetric method to study the millimeter wave absorption in Al, and to determine whether a magnetic field effect can be observed with this method. The absorptivity of Al was investigated at photon energies smaller and larger than the zero-temperature superconducting energy gap. The results indicate that a magnetic field increases the absorptivity for photon energies of the size of the zero-temperature energy gap. Intermediate-state effects are negligible, and the effects observed at 3 and 4 kT_c are assigned to the superconducting state. The results are compared with previous experiments and theory, and the possible dependence of the energy gap on the field is considered. (D.L.C.)

14457 MAGNETIC FIELD DEPENDENCE OF THE MICROWAVE SURFACE IMPEDANCE OF SUPERCONDUCTING ALUMINUM. R. Glosser and D. H. Douglass, Jr. (Univ. of Chicago). 5p. (CONF-651-48)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The microwave (8.8 kMc) surface impedance of superconducting Al at reduced temperature = 0.87 shows anomalous behavior in an external magnetic field. For fields small compared to the critical field, the surface resistance decreases by less than 1%. The effect depends on the orientation, having a two-fold symmetry about θ. The temperature dependence at the resistance minimum was determined. (D.L.C.)

14458 SUPERCONDUCTIVE DEVICES. Paul S. Swartz and Carl H. Rosner (to General Electric Co.). U. S. Patent 3,158,792. Nov. 24, 1964. Filed Nov. 2, 1961.

The superconductive device described includes a solid high-field superconductive body having an aperture through it. Means are provided to produce a magnetic field within the aperture and generally parallel to its axis, to maintain the temperature of the body below its critical temperature, and to compress variably the magnetic field. (A.G.W.)

14459 SUPERCONDUCTIVE DEVICE. Paul S. Swartz (to General Electric Co.). U. S. Patent 3,158,793. Nov. 24, 1964. Filed June 8, 1962.

The superconductive device described includes a high-field superconductive solenoid having an aperture through it. The solenoid is coated with nonsuperconducting material. Means are provided to produce a magnetic field within the aperture and generally to its axis, to maintain the temperature of the solenoid below its critical temperature, and to compress the magnetic field. (A.G.W.)

14460 HIGH FIELD SUPERCONDUCTIVE DEVICE. Paul S. Swartz (to General Electric Co.). U. S. Patent 3,161,809. Dec. 15, 1964. Filed June 14, 1962.

A high-field superconductive device with a length substantially greater than its diameter is formed by providing a high-field superconductive body having an aperture through it, producing a constant magnetic field generally parallel to the axis of the aperture within successive adjacent portions of the aperture, and cooling simultaneously associated successive adjacent protons of the body below their critical temperature to provide a normal-to-superconducting transition within the magnetic field. Thus the body becomes superconducting and confines the magnetic field within the aperture. The device requires no large expensive apparatus and no substantial power supply. (A.G.W.)

Neutron Physics

Refer also to abstracts 14506 and 14793.

14461 (AEEW-M-469) 'PRIZE'—A PROGRAM FOR CALCULATING COLLISION PROBABILITIES IN R-Z GEOMETRY. H. H. W. Pitcher (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Oct. 1964. 11p. Dep.; $0.30(BIS); 1s. 9d.(HMSO).

PRIZE is an IBM 7090 program which computes collision probabilities for systems with axial symmetry and outputs them on cards in suitable format for the PIP1

program. Its method of working, data requirements, output, running time, and accuracy are described. The program was used to compute non-escape (self-collision) probabilities of finite circular cylinders, and a table is given by which non-escape probabilities of slabs, finite and infinite circular cylinders, infinite square cylinders, cubes, spheres, and hemispheres may quickly be calculated to ½% or better. (auth)

14462 (EUR-2161.f) ÉTUDE ÉXPERIMENTALE DE LA PROPAGATION DE NEUTRONS MONOÉNERGÉTIQUES DANS L'EAU. (Experimental Study of Monoenergetic Neutrons Propagation in Water). R. Nicks, N. Papmehl, H. Penkuhn, G. Perlini, C. Pleinevaux (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy); C. Manduchi, and G. Zago (Padua. Universita. Istituto di Fisica). 1964. 100p. Dep.(mn).

Neutron propagation in water has been measured with monoenergetic sources. Neutrons were produced by the target of a Van de Graaff accelerator. A set of experimental removal cross sections is given, as a function of energy, for water and oxygen. (auth)

14463 (EUR-2179.e) THE ACTIVITIES OF THE EURATOM DOSIMETRY WORKING GROUP FOR THE PERIOD SEPTEMBER 1962 TO JUNE 1964. P. Delattre (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay); and K. Gubernator (European Atomic Energy Community). 1964. 17p. (CONF-621-2). Dep. (mn).

From IAEA Panel on In-Pile Dosimetry, Vienna, July 1964.

The activities of the Euratom Dosimetry Working Group from September 1962 to June 1964 are reported. In this period the 7th to 12th Plenary Meetings as well as several meetings of sub-groups were held. Topics discussed included measurements on thermal neutrons and low-energy intermediate neutrons and measurements on high-energy intermediate neutrons and fast neutrons. (C.H.)

14464 (LA-3060) A METHOD OF MOMENTS FOR SOLVING THE NEUTRON TRANSPORT EQUATION. Bengt G. Carlson (Los Alamos Scientific Lab., N. Mex.). July 14, 1964. Contract W-7405-eng-36. 46p. Dep.; $2.00(cy), 1(mn) CFSTI.

A discussion is given of a method of moments in neutron transport theory which is an extension of the well-known spherical harmonic method though not based on orthogonal polynomials. (auth)

14465 (LA-3186) DISCRETE ORDINATES ANGULAR QUADRATURE OF THE NEUTRON TRANSPORT EQUATION. K. D. Lathrop and B. G. Carlson (Los Alamos Scientific Lab., N. Mex.). Sept. 21, 1964. Contract W-7405-eng-36. 48p. Dep.; $3.00(cy), 1(mn) CFSTI.

Methods of preparing discrete ordinates quadrature coefficients are described. Quadrature sets which satisfy complete symmetry conditions and various moment conditions are derived and tabulated, and critical thicknesses of one-dimensional slabs, spheres, and cylinders are calculated with these sets. Prescriptions for relaxing symmetry conditions and point location requirements are discussed, and orthogonal (Legendre-Chebyschev) quadrature coefficients applicable in one-dimensional cylindrical or two-dimensional rectangular geometry are tabulated. Recipes are described for preparing biased direction sets, and a method of basing the bias upon material composition is outlined. Preliminary computational results indicate that double Legendre and half-range moment satisfying quadrature sets are most accurate in one-dimensional plane geometry, while even-moment satisfying, completely symmetric sets are recommended for other geometries. At the present state of the art of discrete ordinates computations, results indicate that boundary condition treatment and, in curved geometries, the handling of the ray-to-ray transfer (streaming) terms can affect accuracy as much as further refinement of angular quadrature. Since computational results may depend upon all three of these quantities, further work is needed before an optimum quadrature method can be selected. (auth)

14466 (ORNL-TM-842) EXTERMINATOR—A MULTIGROUP CODE FOR SOLVING NEUTRON DIFFUSION EQUATIONS IN ONE AND TWO DIMENSIONS. T. B. Fowler, M. L. Tobias, and D. R. Vondy (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 63p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The program described solves the finite-difference analogs of the multigroup neutron diffusion equations in one and two dimensions, using an IBM-7090 computer. The coordinate systems permitted are rectangular (X-Y) and cylindrical (R-Z and R-Θ). Scattering from any group to any other group is allowed. Outside boundary conditions are either symmetry, zero flux, or periodic, and internal control rod boundaries may be specified. The user may employ group- and material-dependent transverse bucklings where appropriate. Input cross sections may be macroscopic, microscopic, or both. Microscopic cross sections may be used from a previously made tape, from cards, or both. Eigenvalue, constant source, or poison search problems may be solved. Up to 50 groups, 500 materials, and 20,000 mesh points are allowed. (auth)

14467 (PAN-545/IXA) THE THERMALIZATION THEORY WITH A SIMPLE SCATTERING KERNEL. J. Mika (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Aug. 1964. 32p. Dep.

The normal-mode expansion method is applied to the Boltzmann equation in plane geometry. The simple, isotropic, separable kernel is used. With such a kernel the energy-dependent thermalization theory is described in terms of the singular integral equations in a way quite similar to that in the one-velocity approximation. In particular, the solutions of the Milne problem and for two adjacent half-spaces allow the determination of the boundary conditions for the asymptotic neutron distribution. (auth)

14468 (RPI-328-18) EXPAND—A SET OF THREE INTERRELATED FORTRAN II PROGRAMS. R. L. Hobson (Rensselaer Polytechnic Inst., Troy, N. Y.). Nov. 1964. Contract AT(30-3)-328. 35p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The EXPAND program is a compendium of three separate FORTRAN II programs. EXPAND solves the homogeneous, infinite-medium Boltzmann equation for the neutron spectrum in both the steady-state and/or time-dependent conditions, by expanding the symmetrized equation in a set of arbitrary orthogonal functions that are supplied by the user. The program can also be used in a finite medium in the diffusion approximation, by adding a DB^2 term to the absorption. The program is presented as written for the Philco 2000 computer. (T.F.H.)

14469 (UCRL-11760) AN IMPROVED METHOD OF NEUTRON SPECTROSCOPY USING THRESHOLD DETECTORS (thesis). Arthur Degen Kohler, Jr. (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 11, 1964. Contract W-7405-eng-48. 75p. Dep.(mn); $3.00 (cy), 2(mn) OTS.

A technique of measuring neutron-energy spectra in the range 2.5 to 30 Mev has been developed. In this technique threshold detectors are exposed to the unknown neutron flux. The activities of residual nuclei from (n,p), (n,a), and (n,2n) threshold reactions are measured by gamma-spectrum analysis. Experimental excitation functions are used. Measured activities and cross sections form a set of integral equations, which are solved for the neutron spectrum by using a least-squares technique. Neutron-reaction cross sections are not well known above about 20 Mev, and 30 Mev is selected as the highest energy for which this method is feasible. An approximate correction is made to measured activities to account for activation caused by neutrons with energies above 30 Mev. Application of this improved technique is demonstrated in experiments with a $^{9}Be(d,n)^{10}B$ neutron source, and the neutron spectra in a thick concrete shield exposed to a 6.2-Bev proton beam. (auth)

14470 (WAPD-BT-31(p.27-35)) THE CALCULATION OF ARTIFICIAL DIFFUSION THEORY CONSTANTS TO

REPRESENT BLACKNESS REGIONS IN OVERLAPPING ENERGY GROUP MODELS. S. Kaplan and R. J. Breen (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The overlapping group method for solving the multi-energy neutron diffusion equations and the blackness theory boundary conditions appropriate to this method are reviewed. A procedure is derived for calculating matrices of artificial constants which cause these boundary conditions to be enforced. For the Buslik version of the overlapping group method it is shown that these matrices are real and symmetric. (auth)

14471 (WAPD-BT-31(p.51-8)) A RITZ FINITE DIFFERENCE APPROXIMATION TO THE NEUTRON DIFFUSION EQUATION. R. B. Kellogg (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

A Ritz finite difference approximation to the neutron diffusion equation on a general set of mesh points is derived. Some properties of the difference equations are discussed. (auth)

14472 (WAPD-T-1718) USE OF SUPERPOSITION PRINCIPLE IN MONTE CARLO RESONANCE ESCAPE CALCULATIONS. E. M. Gelbard and J. Spanier (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1964. Contract AT-11-1-GEN-16. 10p. (CONF-654-29). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting. San Francisco, Nov.-Dec. 1964.

A Monte Carlo method is developed, based on the superposition principle, for calculations of the resonance escape probability (P). The method is quite accurate for P near 1, and is suitable for a wide range of P. The method is found to be practical and accurate by comparing it with the results of a slab-lattice calculation using RESQ-1, an experimental resonance escape code. (T.F.H.)

14473 THE EFFECT OF EXPERIMENTAL RESOLUTION ON CRYSTAL REFLECTIVITY AND SECONDARY EXTINCTION IN NEUTRON DIFFRACTION. O. W. Dietrich and J. Als-Nielsen (Atomenergikommissionen, Roskilde, Denmark). Acta Cryst., 18: 184-8(Feb. 10, 1965). (RISO-72)

The reflectivity for neutrons of a plane slab crystal was calculated in the transmission case when the crystal is placed between two Soller collimators. The calculations indicated that the crystal reflectivity, as well as the secondary extinction coefficient, depends significantly on the angular resolution of the collimators. Curves are given for the extinction of the crystal with different crystal and collimator parameters. (auth)

14474 A DERIVATION OF THE DIFFUSION COEFFICIENT FROM THE NEUTRON TRANSPORT THEORY. Paul Kuttner. Atomkernenergie, 9: 427-30(Nov.-Dec. 1964). (In German)

A term for the neutron diffusion coefficient is derived from Boltzmann's transport theory. This term contains all nuclear reactions, in which neutrons will occur and is therefore a form for the diffusion coefficient improved by transport theory. (auth)

14475 SYSTEMATIC APPROXIMATIONS OF NEUTRON FIRST-COLLISION PROBABILITIES. R. Bonalumi (CISE, Milan). Energia Nucl. (Milan), 12: 1-16(Jan. 1965).

Some methods systematizing the approximate calculation of collision probabilities are described. A general method is found for calculating self-collision probabilities in non-circular cylinders. A very simple approximation to some transport integrals is proposed and successfully tested. A general method for evaluating self-collision probabilities in multiply connected regions is proposed. A method is given for the evaluation of interaction probabilities inside a cluster. (auth)

14476 SCATTERING OF SLOW NEUTRONS FROM AMMONIA AND HYDROGEN SULFIDE. K. A. Strong, Y. D. Harker, and R. M. Brugger (Phillips Petroleum Co., Idaho Falls, Idaho). J. Chem. Phys., 42: 1568-72(Mar. 1, 1965).

Measurements of the scattering of slow neutrons from samples of gaseous ammonia and hydrogen sulfide were made using the MTR phased-chopper velocity selector. The energies of incident neutrons were 0.025, 0.07, and 0.1 ev and the scattered neutrons were detected in counter banks in an angular range of 16 to 145°. The data obtained were converted to reduced partial differential cross sections and were compared with theoretical calculations based on scattering from a symmetric top molecule, from a spherical top molecule, and from a Krieger–Nelkin gas. The symmetric top gave the best fit to the data for both samples. This theory fit the ammonia data better than the hydrogen sulfide data; the deviation was at large energy transfers and was larger for hydrogen sulfide than for ammonia. The zeroth and first moments of energy transfer were obtained from the data for the experimental range of momentum transfer. The zeroth moments for ammonia agreed with the predicted values based on classical theory, but they were about 10% high for hydrogen sulfide. The experimental first moments for both molecules suggested an effective mass roughly 20% lower than the Sachs–Teller mass. (auth)

14477 REFLECTIVITY OF COLLIMATED NEUTRONS BY A MOSAIC SINGLE CRYSTAL. Nobuhiko Kunitomi, Masanobu Sakamoto, Yoshikazu Hamaguchi, and Hiroshi Betsuyaku (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 19: 2280-5(Dec. 1964).

The reflectivity of neutrons by a single crystal with mosaic structure was calculated by Bacon and Lowde considering the effect of the secondary extinction. Their theory was modified so as to take the effect of neutron beam collimation into account. The calculated result that the reflectivity should decrease with increasing collimation is experimentally verified for lead and lithium fluoride as monochromating crystals. Furthermore, the results indicate that the mosaic spread should be suitably chosen to obtain the highest reflectivity for each collimation system. (auth)

14478 SEMI-EMPIRICAL DETERMINATION OF THERMAL NEUTRON SPECTRUM PARAMETERS BY MEANS OF CADMIUM FILTERS. Jacek Arkuszewski and Wlodzimierz Kaczmarek (Inst. of Nuclear Research, Warsaw). Nukleonika, 9: 847-56(1964).

A method for determining the effective neutron temperature and the thermal cut-off energy was derived. The method is based on the FERMI model for a diffusive medium where neutrons are absorbed only in the thermal range and according to the inverse-speed law with a constant scattering cross-section, the escape of neutrons from the system is negligible and detectors are immersed in the isotropic and homogeneous neutron bath. Formulas were derived theoretically and the effective Cd cut-off energy vs cut-off energy, both normalized, were plotted; the curves show a distinct difference between thin and thick Cd filters. The experimental part was done on a graphite exponential system. The results indicate that both the filters and detectors used in measurements were too large. Rechecking and modifications of the method are suggested. (ATD)

14479 NEUTRON PULSE GENERATOR IGN-200. Stefan Chwaszczewski and Kazimierz Dybowski (Inst. of Nuclear Research, Warsaw). Nukleonika, 9: 897-900 (1964). (In Polish)

The design and construction of a neutron impulse generator is described. It is intended for the study of neutron diffusion in multiplying and moderating media. The wide range of generated impulse lengths and of their rate of repetition make the instrument suitable for other applications also. The neutrons are produced by bombarding a tritium target with accelerated deuterons; the neutron flux is modulated by modulating the deuteron flux in the accelerator. The generator output is 10 neutrons per microsecond, their energy is 14 Mev, the impulse width ranges from 1 microsecond to infinity, their rate of repetition can vary from 0 to 1.5 kc. The apparatus contains an ion source, and is provided with a power supply, steering, controls, a cooling system, a vacuum system, and a meter panel. The diffusion parameters of neutrons in water were already measured with satisfactory results. (ATD)

14480 MEASUREMENTS OF NEUTRON YIELD FROM PULSED NEUTRON TUBES. R. D. Vasil'ev, G. A. Dorofeev, V. I. Petrov, and M. I. Pimenov. Pribory i Tekhn. Eksperim., No. 6, 32-3(Nov.-Dec. 1964). (In Russian)

Descriptions are given of an activation method for determining neutron yield from pulsed neutron tubes by means of a device, calibrated in a continuous neutron flux. The mean number of neutrons in a pulse was $\sim 5 \times 10^6$. (R.V.J.)

14481 ABSOLUTE MEASUREMENT OF THE COHERENT SCATTERING LENGTH OF MERCURY WITH THE NEUTRON GRAVITY REFRACTOMETER AT FRM. L. Koester (Technische Hochschule, Munich). Z. Physik, 182: 328-36(1965). (In German)

The gravity refractometer at the Munich Research Reactor is described. The slow neutron spectra were measured at 170 to 900 m/sec, and the coherent scattering length of mercury was found from reflection measurements, to be $a_{coh} = \pm(12.69 \pm 0.02) \times 10^{-13}$ cm. (tr-auth)

14482 INELASTIC SCATTERING OF ROOM TEMPERATURE NEUTRONS FROM POLYETHYLENE. J. L. Donovan, G. C. Summerfield, and J. S. King. 12p. (CONF-640606-5).

From American Physical Society Summer Meeting, Denver.

Warm neutrons scattered from variable incident energies to a fixed final energy of 0.0268 ev were observed, using a triple axis crystal spectrometer and polyethylene samples at 298 and 130°K. Data were fitted to the one-phonon, incoherent approximation for downscatter, and the frequency spectrum was derived. It is found that there is a strong temperature effect on the frequency spectrum and, in contrast to previous data, a significant increase in the spectrum above about 0.025 ev. These changes are ascribed in part to multiple phonon events. (M.J.T.)

Nuclear Properties and Reactions

Refer also to abstracts 13281, 13422, 13756, 13772, 13775, 13777, 13789, 14309, and 14797.

14483 (AD-603601) RESONANCES IN THE $S^{32,33,34}(p,\gamma)Cl^{33,34,35}$ REACTIONS WITH BOMBARDING ENERGIES IN THE ONE Mev TO TWO Mev RANGE (thesis). Anthony Kalil Hyder, Jr. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). May 1964. 73p. (GSP/Phys/64-6). $3.00(OTS).

A search for resonances in the reactions (p,γ) on ^{32}S, ^{33}S, and ^{34}S for proton energies in the one to two Mev range was conducted. Natural sulfur targets, in elemental form with a thin gold overlay, with thicknesses of about 5 kev for 1.5-Mev protons, and enriched ^{33}S and ^{34}S targets, in Ag_2S compound form, with thicknesses of about 1–2 kev for 1.5-Mev protons, were used. Gamma rays were detected at 55 degrees relative to the proton-beam direction. In each of the three yield curves, pulses were counted simultaneously with three scalers biased for selected gamma energies. Approximately thirty ^{34}S resonances were found in the energy region studied. Most of the observed resonance widths were less than or equal to 2 kev. In the ^{33}S yield curve, twelve prominent resonances, with widths less than or equal to 2 kev, were observed in addition to others previously known. Above 1600 kev, evidence for many weak, closely-spaced ^{33}S resonances was found. (auth)

14484 (AECL-2148) A DETERMINATION OF THE RATIO OF CAPTURE-TO-FISSION CROSS SECTION OF U^{233}. A. Okazaki, M. Lousbury, and R. W. Durham (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1964. 14p. Dep.; $0.50(AECL).

The neutron capture to fission cross section ratio (α) for ^{233}U has been determined for two samples of $^{233}U-Al$ alloy irradiated to 2.29 and 2.90×10^{21} neutrons/cm^2 in the NRU reactor. The changes in isotopic composition and total uranium content with irradiation were determined by mass spectrometric and isotopic dilution analyses. The average value of α obtained was 0.0940 ± 0.0004 for the irradiation in a neutron spectrum having r = 0.022 ± 0.004 and T = 40°C. The 2200 m/sec value of $\alpha_0 = 0.00939 \pm 0.0009$ was derived from the measured α. (auth)

14485 (ANL-6878) NUCLEAR SPECTROSCOPY WITH DIRECT REACTIONS. II. PROCEEDINGS. F. E. Throw, ed. (Argonne National Lab., Ill.). Mar. 1964. Contract W-31-109-eng-38. 539p. (CONF-396). Dep.; $5.50 (OTS).

Twenty-two papers and several abstracts and discussions are included; separate abstracts have been prepared for 15. Seven papers were previously abstracted in NSA, Vol. 18, as abstracts number 21204, 21299, 21301, 24400, 28752, 32880, and 32881. (T.F.H.)

For abstracts of individual papers see: 14486, 14487, 14488, 14489, 14490, 14491, 14492, 14493, 14494, 14495, 14496, 14497, 14498, 14499, and 14500.

14486 (ANL-6878(p.23-60)) DISTORTED-WAVE CALCULATIONS AND SPECTROSCOPIC FACTORS. G. R. Satchler (Oak Ridge National Lab., Tenn.).

Results of distorted-wave calculations of (d,p) reactions with ^{40}Ca, ^{114}Cd, and ^{88}Sr; $(^3He,\alpha)$ reactions with ^{40}Ca and ^{56}Fe; and $^{90}Zr(p,\alpha)$ and $^{19}F(\alpha,^6Li)$ are presented. A detailed analysis of $^{40}Ca(d,p)$ is carried out. (T.F.H.)

14487 (ANL-6878(61-83)) STRIPPING REACTIONS WITH DEUTERONS. L. L. Green (Liverpool. Univ.).

The (d,p) reaction with ^{52}Cr is studied experimentally and by distorted-wave calculations at deuteron energies of 7 to 11 Mev. The related reactions, viz. (p,p) with ^{53}Cr and (d,d) with ^{50}Cr, ^{52}Cr, ^{53}Cr, and ^{54}Cr, are also analyzed. Results of analyses for (d,p) reactions with ^{238}U and ^{90}Zr are also presented. (T.F.H.)

14488 (ANL-6878(p.85-9)) A STUDY OF THE REACTION $U^{238}(d,p)U^{239}$. B. E. F. Macefield (Oxford Univ.) and R. Middleton (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England).

Spectra and angular distributions for the $^{238}U(d,p)^{239}U$ reaction are measured and compared with the predictions of the Nilsson model and DWBA calculations. (T.F.H.)

14489 (ANL-6878(p.143-73)) INELASTIC SCATTERING. J. S. Blair (Washington. Univ., Seattle).

The uses of analysis of nuclear scattering cross sections in determinations of spins, parities, deformation parameters, and wave functions of nuclear excited states are illustrated, using the scattering of protons, deuterons, and alpha particles by a variety of nuclei as examples. (T.F.H.)

14490 (ANL-6878(p.175-80)) INELASTIC SCATTERING ON Ti^{48}. Larry Zamick (Princeton Univ., N. J.).

The distributions and selection rules involved in proton inelastic scattering by ^{48}Ti are analyzed within the shell model of the nucleus. (T.F.H.)

14491 (ANL-6878(p.181-206)) ISOBARIC-SPIN EFFECTS IN NUCLEAR REACTIONS. J. B. French (Rochester, N. Y. Univ.).

The effects of isobaric spin on nuclear reactions, intranuclear nucleon interactions, and nuclear energy levels are within the nuclear shell model. (T.F.H.)

14492 (ANL-6878(p.207-13)) EXCITATION OF ANALOGUE STATES IN REACTIONS. R. Sherr (Princeton Univ., N. J.).

Experimental and theoretical analyses are presented of the excitation energies, angular distributions, and strengths, for transitions to isobaric analog states in (p,d) reactions with nuclei. (T.F.H.)

14493 (ANL-6878(p.215-29)) (p,n) REACTIONS AND ISOBARIC ANALOGUE STATES. J. D. Anderson (California. Univ., Livermore. Lawrence Radiation Lab.).

Experimental angular distributions are presented for isobaric-analog (p,n) reactions with nuclei between ^9Be and ^{93}Nb. The distributions are analyzed theoretically in terms of the optical nuclear model. (T.F.H.)

14494 (ANL-6878(p.249-75)) SINGLE-NUCLEON SPECTROSCOPIC FACTORS AND NUCLEAR MODELS. M. H. Macfarlane (Argonne National Lab., Ill.).

A survey is presented of analyses of single-nucleon

transfer reactions with nuclei. The relations between the models used and the nuclear spectroscopic factors are reviewed. The models used are simple, and emphasize the single-particle aspects of nuclear structure. (T.F H.)

14495 (ANL-6878(p.279-301)) SPIN MEASUREMENTS AND STRIPPING REACTIONS. John P. Schiffer (Argonne National Lab., Ill. and Princeton Univ., N. J. Palmer Physical Lab.).

A review is presented of methods for removing experimental ambiguities in nuclear spins, as measured using single-nucleon-transfer reactions with spin-zero nuclei. (T.F.H.)

14496 (ANL-6878(p.335-50)) NUCLEAR-STRUCTURE INFORMATION FROM MANY-PARTICLE TRANSFER REACTIONS. Benjamin F. Bayman (Princeton Univ., N. J. Palmer Physical Lab.). (PUC-1964-140).

It is shown that a study of the coherences characteristic of many nucleon-transfer nuclear reactions, within the framework of a distorted-wave analysis, can yield information as to the nuclear structure. (T.F.H.)

14497 (ANL-6878(p.353-422)) DEUTERON-TRANSFER REACTIONS. D. Allan Bromley (Yale Univ., New Haven).

The nuclear-spectroscopic uses of deuteron-transfer nuclear reactions involving incident particles from single nucleons to ^{11}B nuclei are summarized. Areas in which this type of reaction is able to provide information on nuclear structure are surveyed. The ambiguities encountered in the use of this type of reaction are discussed. (T.F.H.)

14498 (ANL-6878(p.425-48)) PAIRWISE STRIPPING AND PICKUP REACTIONS. N. M. Hintz (Minnesota. Univ., Minneapolis).

The nuclear-spectroscopic uses of stripping and pickup reactions involving transfer of two like or unlike nucleons are discussed. Examples are given of comparisons of experimental data with theoretical predictions. (T.F.H.)

14499 (ANL-6878(p.457-77)) DIRECT-REACTION CONTRIBUTIONS TO FLUCTUATING REACTION CROSS SECTIONS. G. M. Temmer, B. Teitelman, and F. G. Fender (Rutgers Univ., New Brunswick, N. J.).

An analysis is presented of (p,α) reactions on ^{19}F, ^{27}Al, ^{59}Co, ^{23}Na, and ^{15}N, leading to a multiplicity of states of the residual nuclei. Cross sections and their fluctuations are measured. The mechanisms for these reactions are investigated. Statistical, direct, and compound-nucleus processes are discussed. (T.F.H.)

14500 (ANL-6878(p.481-504)) HIGH-ENERGY REACTIONS AND NUCLEAR STRUCTURE. H. J. Lipkin (Weizmann Inst. of Science, Rehovoth, Israel).

The possibility of the use of concepts commonly used in high-energy elementary particle interactions (e.g., Feynman diagrams, peripheral model) in the analysis of spectroscopic properties of nuclei is discussed. The relations between the terminology used by high-energy elementary-particle physicists and low-energy nuclear-structure physicists are shown. The use of the high-energy terminology in the analysis of the Mössbauer effect is described. (T.F.H.)

14501 (AWRE-O-100/64) NEUTRON CROSS SECTIONS OF U-233 IN THE ENERGY RANGE 4 TO 15 Mev. A. C. Douglas (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Jan. 1965. 22p. Dep.(mn).

Recommended values are given for the neutron total and partial cross sections of U-233 in the energy range 4 to 15 Mev. The scant experimental evidence is surveyed and supplemented by estimates based on nuclear theory and systematics. The values given in this report were combined with previous data below 4 Mev. (auth)

14502 (AWRE-O-101/64) NEUTRON CROSS SECTIONS OF Pu-241 IN THE ENERGY RANGE 1 Kev TO 15 Mev. A. C. Douglas (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Feb. 1965. 64p. Dep.(mn).

Recommended values are given for the neutron total and partial cross sections of ^{241}Pu in the energy range 1 kev to 15 Mev. The scant experimental evidence is surveyed and supplemented by estimates based on nuclear theory. Details of energy and angular distributions are given so that the data are complete for the purpose of neutronics calculations. The values given in this report were combined with data below 1 kev and were written on punched cards as part of the UKAEA Nuclear Data Library. (auth)

14503 (BNL-897) ANALYSIS OF (n,2n) CROSS SECTIONS FOR NUCLEI OF MASS A > 30. S. Pearlstein (Brookhaven National Lab., Upton, N. Y.). Dec. 1964. Contract AT-30-2-GEN-16. 48p. (EANDC(US)-71(U)). Dep.; $3.00(cy), 2(mn) CFSTI.

The ability of the statistical model of nuclear reactions to interpret measured (n,2n) cross sections was tested. Good agreement was observed for 22 nuclei having mass numbers greater than 30. The statistical model was then applied to all nuclei in this mass range to estimate both monoenergetic and fission spectrum averaged cross sections. (auth)

14504 (BNL-904) OPTICAL MODEL ANALYSIS OF THE NEUTRON-SODIUM CROSS SECTION IN THE 1-4 Mev RANGE. Neutron Cross Section Evaluation Group Newsletter No. 8, January 1965. T. J. Krieger and S. Pearlstein (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 6p. Dep.; $1.00(cy), 1(mn) CFSTI.

Fair fits to the experimental neutron differential elastic and total cross section of ^{23}Na in the 1-4 Mev range are obtainable by least squares fitting of optical model digit computer calculations with the ABACUS II code. Further confidence in the optimum choice of parameter values so found is gained from the good fit which results when these values are used in a Hauser-Feshbach calculation of the partial inelastic scattering cross sections to individual excited states. The preliminary results reported indicate that the optical model can be applied with reasonable success to the analysis of the neutron-sodium cross section in the 1-4 Mev range. In addition, they tend to encourage the application of the technique to other relatively light nuclei. (auth)

14505 (BNL-8508) STUDIES OF ALPHA-PARTICLE EMITTING STATES OF C^{12} OBSERVED IN THE REACTIONS $B^{10}(He^3,p)C^{12}(\alpha)Be^8$ AND $C^{13}(He^3,\alpha)C^{12}(\alpha)Be^8$. D. E. Alburger (Brookhaven National Lab., Upton, N. Y.) and P. F. Donovan (Bell Telephone Labs., Inc., Murray Hill, N. J. and Brookhaven National Lab., Upton, N. Y.). Oct. 7, 1964. Contract [AT(30-2)-Gen-16]. 11p. (CONF-641005-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Correlation of Particles Emitted in Nuclear Reactions, Gatlinburg, Tenn.

Proton-alpha coincidences occurring in the $^{10}B(^3He,p)^{12}C(\alpha)^8Be$ reaction were measured by using a 2.0-Mev ^3He beam incident on a 50 $\mu g/cm^2$ thick ^{10}B target and by detecting the particles in two silicon solid-state detectors. An 18 mg/cm^2 thick Al absorber excluded alpha particles from the proton detector. Data were stored in a TMC 128 × 128-channel pulse-height analyzer and runs were made at several θ_p and θ_α angles. Energy spectra of protons in coincidence with the alpha particles leading both to the ground state of ^8Be and to the broad 2.9-Mev first excited states were plotted. The 9.63, 10.8, and 14.1-Mev levels of ^{12}C were observed to decay to ^8Be ground state demanding natural parity for these states. In the (p,α) spectrum leading to the ^8Be 2.9-Mev level the decays of the 11.8, 12.7, 13.3, 14.1, 16.1, and 16.6-Mev levels appear. Unnatural parity is indicated for the 11.8, 12.7, and 13.3-Mev states. From the absence of a peak in the latter spectrum corresponding to the 15.1-Mev, 1+, T = 1 level of ^{12}C an upper limit of 0.05 is placed on Γ_α/Γ for this state. Similar experiments were carried out on the $^{13}C(^3He,\alpha)^{12}C(\alpha)^8Be$ reaction at 3 Mev by detecting $\alpha-\alpha$ coincidences. Although the 15.1-Mev level is strongly populated in the reaction, no evidence could be found for its α decay to the ^8Be 2.9-Mev level and an upper limit of 0.05 is placed on

Γ_α/Γ. The above results represent a sharper limit on the isotopic-spin-violating alpha decay in the 15.1-Mev state than any previously reported. (auth)

14506 (BNL-8710) ROLE OF THE COMPUTER IN NEUTRON RESONANCE PARAMETER ANALYSIS. R. E. Chrien (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT-30-2-GEN-16. 33p. (CONF-641004-1). Dep.(mn); $2.00(cy), 1(mn) OTS.

From American Physical Society, Chicago.

A system is described whereby neutron time-of-flight data are collected and initially processed in a small computer, and further analyzed in a large central computing facility. The method is applicable to studies of neutron total cross sections and slow neutron resonances. (T.F.H.)

14507 (BNL-8745) SUPERCONDUCTING MAGNETS—APPLICATIONS TO THE MÖSSBAUER EFFECT. Paul P. Craig (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT-30-2-GEN-16. 14p. (CONF-650101-1). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Mössbauer Symposium, New York.

The factors involved in choosing between superconducting and conventional electromagnets for studies of the Mössbauer effect are reviewed. These include field homogeneity and strength requirements, economics, design flexibility, technological status, capability of producing steady or oscillating fields, and capability of producing fields having gradients. (T.F.H.)

14508 (BNL-8858) FISSION OF HEAVY ELEMENTS BY HIGH-ENERGY PROTONS. Gerhart Friedlander (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT-30-2-GEN-16. 27p. (CONF-650301-4). Dep.(mn); $2.00(cy), 1(mn) OTS.

From Symposium on the Physics and Chemistry of Fission, Salzburg, Austria.

A brief survey is given of the phenomenology of fission-like break-up processes induced in high-Z elements by protons of high energies, with principal emphasis on the Bev region. Charge dispersions are discussed in some detail. New charge dispersion data in various mass regions for products formed in lead and uranium interactions with 2.9 and 28-Bev protons are reviewed. The pronounced differences between the lead and uranium results are discussed. The double-humped charge dispersion curves observed near A = 130 for uranium fission products are interpreted in terms of two different mechanisms, characterized by low and high deposition energies. This interpretation is confirmed by recoil experiments, particularly by data on angular distributions and range spectra for neutron-deficient and neutron-excess products of uranium fission. From the charge dispersions, yield vs mass curves for the 2.9- and 28-Bev interactions are constructed, and these are compared with the yield vs mass distributions at lower energies. In the uranium interactions, a single broad maximum, centered at A ≈ 110, is found in the mass distribution, broader at 28 than at 2.9 Bev. With lead as the target, the mass distribution is flat in the region 40 < A < 140. Values of fission cross sections derived from the yield vs mass curves are discussed in the light of fission cross sections obtained by other methods and at other bombarding energies. (auth)

14509 (CEA-R-2624) CONTRIBUTION À L'ÉTUDE DES NIVEAUX EXCITES DU ^{7}Be OBTENUS PAR LA REACTION ^{6}Li(p,α). (Contribution to the Study of Excited Levels of ^{7}Be Obtained from the Reaction ^{6}Li(p,α)). Henri Beaumevieille (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Grenoble). 1964. 64p. Dep.(mn).

The interpretation of the results of the reaction ^{6}Li(p,α) in the energy range 100 kev to 3 Mev was done with the next levels of ^{7}Be: $3/2^-$ (5.9 Mev), $3/2^+$ (6.2 Mev), $5/2^-$ (7.18 Mev), and a level the characteristics of which may be $1/2^+$ or ^{4}P (9.5 Mev). (auth)

14510 (CONF-654-27) A MEASUREMENT OF α FOR U-233 AND U-235 IN THE EPITHERMAL REGION. L. J. Lach and F. Feiner (Knolls Atomic Power Lab., Schenectady, N. Y.). [1964]. Contract W-31-109-eng-52. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Samples of ^{233}U and ^{235}U are irradiated by epithermal neutrons, and the numbers of captures and fissions undergone by each sample are measured by mass spectrography fission-product mass spectrography, radiochemical analysis, and activation analysis. The capture and fission integrals for neutron energies above 0.5 ev are thus found for both ^{233}U and ^{235}U. The capture-to-fission ratios above 0.5 ev are found as 0.165 ± 0.012 and 0.486 ± 0.025 for ^{233}U and ^{235}U respectively. (T.F.H.)

14511 (CONF-640301) SYMPOSIUM ON THE STRUCTURE OF LOW-MEDIUM MASS NUCLEI, MARCH 5 AND 6, 1964, HELD AT THE UNIVERSITY OF KANSAS, LAWRENCE, KANSAS. L. W. Seagondollar, ed. (Kansas. Univ., Lawrence and Aerospace Research Labs., Wright-Patterson AFB, Ohio). Contract [AT(11-1)-1120]. 226p. Dep.(mn); $6.00(cy), 5(mn) OTS.

Nine papers are included; separate abstracts have been prepared for all. (T.F.H.)

For abstracts of individual papers see: 14512, 14513, 14514, 14515, 14516, 14517, 14518, 14519, and 14520.

14512 (CONF-640301(p.1-12)) PROPERTIES OF SOME NUCLEAR STATES IN THE A = 28–40 REGION. P. M. Endt (Utrecht. Rijksuniversiteit).

Shell-model calculations of properties of nuclei in the $2s_{1/2}$ and $1d_{3/2}$ subshells are reported, for nuclei with A = 28 to 40. Experiments undertaken to check these predictions are discussed. (T.F.H.)

14513 (CONF-640301(p.13-21)) COLLECTIVE EFFECTS IN Ca^{41}. J. B. Raz (New York. State Univ., Stony Brook).

The two lowest-lying $3/2^-$ states of ^{41}Ca are explained in terms of the core-plus-particle model and collective interactions. (T.F.H.)

14514 (CONF-640301(p.22-38)) EFFECTIVE INTERACTIONS AND COUPLING SCHEMES IN NUCLEI. S. P. Pandya (Argonne National Lab., Ill.).

A model interaction for describing the nucleon–nucleon interactions in the shell nuclear model is discussed. The model has the properties that it gives satisfactory results when used in the collective model, and is also consistent with experimental observations on extranuclear nucleon–nucleon interactions. The model contains three arbitrary parameters. Experiment and theory are compared for the energy levels of ^{18}O, ^{18}F, ^{20}O, and ^{20}Ne. (T.F.H.)

14515 (CONF-640301(p.39-79)) ANGULAR CORRELATION MEASUREMENTS AND PROPERTIES OF P^{31}. Gale I. Harris (Aerospace Research Labs., Wright-Patterson AFB, Ohio).

The predictions of several nuclear models (the Nilsson model, the weak-coupling vibrational model, the asymmetric-core rotator model, and the shell model) for the excited states and angular correlations of ^{31}P are compared with experimental observations. (T.F.H.)

14516 (CONF-640301(p.80-108)) PROTON CAPTURE REACTIONS IN ^{27}Al. Rolf Nordhagen (Oslo Universitetet).

The properties and decay characteristics of a resonance in ^{27}Al(p,γ)^{28}Si at a gamma energy of 1118 kev are studied. Related studies on other resonances are also carried out. An energy level scheme for ^{28}Si consistent with the gamma spectra observed is given. Angular correlations are studied for the decay of the resonance. (T.F.H.)

14517 (CONF-640301(p.109-42)) ALPHA-CAPTURE REACTIONS IN TRANS-NEONICS. C. van der Leun (Utrecht. Rijksuniversiteit).

Studies are reported of the cross sections, resonance-level characteristics, and multipolarities and mixing ratios of gamma rays de-exciting the resonance levels for (α,γ) reactions with ^{20}Ne, ^{24}Mg, ^{28}Si, ^{30}Si, ^{32}S, ^{34}S, ^{23}Na, and ^{27}Al. The experiments are carried out using a 3-Mev Van de Graaff accelerator. (T.F.H.)

14518 (CONF-640301(p.143-64)) ROTATIONS AND VIBRATIONS IN LIGHT NUCLEI. J. P. Davidson (Rensselaer Polytechnic Inst., Troy, N. Y.).

Collective vibrations and rotations in light nuclei are studied, with emphasis on 2s-1d and 2p-1f nuclei. Experiment and theoretical predictions are compared for several nuclei for which A = 17 to 35. (T.F.H.)

14519 (CONF-640301(p.165-81)) SHELL MODEL STUDIES IN THE NUCLEAR (2s,1d)-SHELL. M. Harvey (Atomic Energy of Canada Ltd., Chalk River, Ont.).

An independent-particle model description of the low-lying energy levels of light nuclei is presented. The implications of several calculations of the properties of some low-lying negative-parity states of nuclei at the beginning of the (2s,1d) shell, within the framework of the Elliott SU_3 model, are investigated. (T.F.H.)

14520 (CONF-640301(p.182-218)) STUDIES OF THE GIANT DIPOLE RESONANCES WITH (p,γ) REACTIONS. S. S. Hanna (Stanford Univ., Calif.).

The use of the (p,γ) reaction, along with shell-model calculations, in order to study the giant dipole resonances in nuclei is described. The method is illustrated for the resonances in ^{12}C and ^{28}Si, excited by the reactions $^{11}B(p,\gamma)$ and $^{27}Al(p,\gamma)$ respectively. (T.F.H.)

14521 (CONF-640606-18) MÖSSBAUER-EFFECT IN Yb^{171}. G. Michael Kalvius (Western Reserve Univ., Cleveland). [1964]. Contract [AT(11-1)-1297]. 17p. Dep. (mn); $1.00(cy), 1(mn) OTS.

From American Physical Society Summer Meeting, Denver.

Recoil-free nuclear resonance absorption of the 67-kev γ ray was observed. ^{171}Tm in the form of the sesquioxide was used as a source, and Yb_2O_3 and Yb-metal were used as absorbers. Source and absorber were held at the same temperatures of 50, 4.2, and 1.6°K. Due to the field gradient present in the oxide crystal, the 67-kev state (I = 3/2) splits into two substates with a separation of 2.4×10^{-6} ev extrapolated to 0°K. The Yb-metal forms a cubic crystal lattice and shows no splitting. The observed line width gives a lower limit of 7×10^{-10} sec for the lifetime of the 67-kev state. Comparison with previous data of others on the hyperfine splitting of the 84-kev level in ^{173}Yb in Yb_2O_3 gives a value of 1.04 for the ratio $Q_0(171)/Q_0(170)$ of the intrinsic quadrupole-moments, which agrees well with the values obtained by Coulomb excitation. (auth)

14522 (DESY-64/12) DIFFERENTIELLER WIRKUNGSQUERSCHNITT FUR DIE ELEKTRONENPAARERZEUGUNG DURCH HOCHENERGETISCHE PHOTONEN. (Differential Cross Section for Electron Pair Production by High-Energy Photons). Gustav Sommer (Deutsches Elektronen-Synchrotron, Hamburg). Oct. 1964. 13p. Dep.(mn).

An approximate formula is given for the differential cross section in electron pair production. The formula is applicable to angles between 1 and 20 degrees (laboratory-system electron angles). (auth)

14523 (JINR-E-1924) ANOMALIES IN THE BINDING ENERGY VALUES OF THE LAST PAIR OF NEUTRONS IN THE RANGE N = 86 + 92. R. A. Demirkhanov, V. V. Dorokhov, and V. G. Soloviev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 7p. Dep.(mn).

The transition boundary from spherical nuclei to deformed ones in the rare-earth region is determined by analyzing the binding energy values of the last pair of neutrons B_{2n}. It is shown that the anomaly in the behavior of B_{2n} is observed both in the case of even-even and even-odd nuclei for N-88 to 91. The value (~0.3-0.6 Mev) is obtained and approximate boundaries in which this effect work are determined. The conclusions drawn on the basis of an exact measurement of the masses and the binding energies analysis are confirmed by the available spectroscopic data on the first rotational state energies. (auth)

14524 (JINR-P-1847) ISSLEDOVANIE NEITRONNO-FONONNYKH VZAIMODEISTVII NA IMPUL'SNOM BYSTROM REAKTORE (IBRe). (An Investigation of Neutron-Phonon Interactions on the Pulsed Fast Neutron Reactor (IBR)). V. V. Nitts, I. Sosnovska, and E. Sosnovski (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1964. 7p. Dep. (mn).

A possibility is shown of studying the inelastic neutron scattering by monocrystals on the pulsed fast neutron reactor by applying the time-of-flight method and the crystal monochromator. Some results are presented for the bismuth monocrystal, the crystal plane (01$\bar{1}$) of which was in the scattering plane. (auth)

14525 (JINR-P-1907) VLIYANIE PARNYKH KORRELYATSII NA E1-PEREKHODY V DEFORMIROVANNYKH YADRAKH. (Effect of Pairing Correlations on the E1 Transitions in Deformed Nuclei). O. G. Gadetstii and N. I. Pyatov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 15p. Dep.(mn).

The calculations of the reduction factors due to the pairing correlations are performed for the electric dipole transitions in the odd deformed nuclei. Use is made of the usual wave functions of the superfluid model (without and with taking into account the blocking effect), as well as of the projected ones. The calculations have shown that R_γ computed with usual Bardeen's functions differ strongly, as a rule, from those computed with the modified functions for the transitions occurring from the particle states to the ground one and for the particle-hole ones. For other types of transitions, R_γ calculated by means of different wave functions are usually different by less than a factor of two. A comparison of the calculated R_γ with the experimental data and with the calculations according to Nilsson's scheme does not allow to prefer a certain form of the wave function. (auth)

14526 (LA-DC-6670) TRANSITION STATES AT THE FISSION BARRIER. James J. Griffin (Los Alamos Scientific Lab., N. Mex.). [1964]. Contract W-7405-eng-36. 19p. (CONF-650301-2). Dep.(mn); $1.00(cy), 1(mn) OTS.

For Presentation at Symposium on the Physics and Chemistry of Fission, Salzburg, Austria.

The transition states a nucleus traverse en route to fission is reviewed, together with the relevant theory of fission-fragment anisotropy. Theoretical progress in understanding this kind of data in terms of nuclear superfluidity is summarized. The evidence indicates that nuclear pairing effects play an important role in determining the transition state spectrum. Experimental (d,pf) data are noted, and their statistical analysis in terms of a pairing Hamiltonian considered in the fixed-energy ensemble appropriate for finite nuclei is presented. The results indicate that such pairing effects lead in ^{240}Pu to an energy gap in the transition spectrum nearly twice that which occurs at the ground state shape of the same nucleus. Such a result is quite significant from the point of view of nuclear many-body physics, suggesting that the nuclear surface plays an important role in the pairing of nucleons in the finite nuclei. The significance for nuclear fission is also broad. Such a large energy gap forces reassessment of certain detailed conjectures which have been put forward concerning fission widths and mass asymmetry associated with capture resonances of specific spin and parity. The situation suggests that the (even-even) and (odd-odd) (spin-parity) correlation which rules in the low energy spectra of deformed even-even nuclei does not prevail in the transition state spectrum. A possible explanation in terms of low-energy mass-asymmetric and bending vibrations of the fissioning nucleus is discussed. (auth)

14527 (LA-DC-6673) EFFECTS OF ORBITAL ANGULAR MOMENTUM AND TARGET SPIN ON FISSION ANISOTROPY. L. Blumberg, Judith Gursky, and R. B. Leachman (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 21p. (CONF-650301-1). Dep. (mn); $1.00(cy), 1(mn) OTS.

Presentation at Symposium on the Physics and Chemistry of Fission, Salzburg, Austria.

Fission anisotropies are measured over a wide range of excitation energies for compound nuclei produced by two different target-projectile pairs (e.g., ^{236}U produced by $n + ^{235}U$ and by $\alpha + ^{232}Th$). Studies based on the standard deviation in the Gaussian distribution of the products, and on the mean-square orbital-angular-momentum quantum number, are carried out, using an analytical expression for the fission anisotropy. Experiments and calculations are compared for several compound nucleus systems. (T.F.H.)

14528 (LAL-1120) SOME EVIDENCE OF NUCLEAR SHELL EFFECTS FOR PHOTOPROTONS. Katsufusa Shoda (Paris. Universite, Orsay. École Normale Supérieure. Laboratoire de l'Accélérateur Linéaire). Nov. 1964. 47p. Dep.(mn).

The energy distributions of photoprotons from nuclei between ^{19}F and Zn are discussed for the residual states. The residual states for strong transitions are found in the ground state for even-Z nuclei and the excited state for odd-Z nuclei. The cross sections are calculated from energy distributions of the photoprotons, assuming complete transitions to the residual states. Comparisons are made and some evidence for shell effects is found. The angular distributions do not contradict the shell model under an assumption of transition to the residual states. Some comparisons with other reactions are also discussed. (auth)

14529 (MMPP-FRPC-64-2) MEASUREMENTS OF FAST NEUTRON CROSS SECTIONS. Lawrence Cranberg (Virginia. Univ., Charlottesville). [1964]. Contract AT(11-1)-1372. 75p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A review of the principal methods of measuring fast neutron cross sections is presented. Neutron sources, fast pulsing techniques, total cross sections, inelastic cross sections, scattering, capture cross sections, and fission are discussed. (C.E.S.)

14530 (NP-14606) COEFICIENTE DE RAMIFICACION EN EL Y^{87}. Informe No. 121. (Coefficient of Ramification [Branching Ratio] of ^{87}Y. Report No. 121). S. J. Nassiff, P. Diodati, and I. L. de Torriani (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires and La Plata. Universidad Nacional). 1964. 9p. Dep.(mn)

The relation between the decays of the 80-hr. level of ^{87}Y to the 0.871-Mev level and to the 0.388-Mev level was determined. 89.5% of the decays go to 0.871 Mev and 10.5% to 0.388 Mev with an error of 1%. (J.S.R.)

14531 (NP-14625) DIE REAKTIONEN $Li^6(d,\alpha)\alpha$ UND $Li^6(d,p)Li^7$ BEI DEUTERONENERGIEN VON 3 BIS 5 Mev (these). (The Reaction $^6Li(d,\alpha)\alpha$ and $^6Li(d,p)^7Li$ at Deuteron Energies of 3 to 5 Mev (thesis)). Walter Pfeifer (Zurich. Universität). 1962. 52p. Dep.(mn).

The reactions $^6Li(d,\alpha)\alpha$ and $^6Li(d,p)^7Li$ were studied at deuteron energies from 2.4 to 5.2 Mev. The apparatus and techniques used for the measurements are described. The angular distributions are shown and the reaction mechanisms are discussed. (J.S.R.)

14532 (NP-14688) ISSLEDOVANIE RADIOAKTIVNOGO RASPADA KYURIYA-242 I KYURIYA-244. (A Study of the Radioactive Decay of Curium-242 and Curium-244). G. G. Akalaev, N. A. Vartanov, and P. S. Samoilov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii). [1963]. 7p. Dep.(mn).

Electron and γ spectra of curium isotopes were studied using a 1.5×30 mm strip placed on a 0.1 μ celluloid film which permitted the recording of electrons starting at 1 kev. The measurements were carried out with a β spectrometer with double focusing at $\pi\sqrt{2}$ angle. The general spectra for (0.8 to 120)-kev electrons exhibited 15 electron lines with a strong burst of Auger electrons appearing in $M_1 - N_jX_k$ transitions. The ^{242}Cm isotopes were prepared by ^{241}Am thermal neutron bombardment in a reactor: $^{241}Am(n,\gamma)^{242m}Am \xrightarrow{\beta^-,\ 16hr} {}^{242}Cm$. The mean energy of the electron transitions was 44.09 kev. The L and M lines were found and estimated. (R.V.J.)

14533 (NYO-1082-1) REACTION STUDIES WITH FAST NEUTRONS: REPORT OF PROGRESS TO OCTOBER 31, 1964. R. A. Peck, Jr. and D. R. Maxson (Brown Univ., Providence). Nov. 1, 1964. Contract AT(30-1)-1082. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Instrumental developments are reported concerning completion and application of an electronic particle discrimination system and several detector assemblies of various designs; completion of beam analyzing magnet, feasibility study of production of 14 Mev protons by ^3He acceleration, and modifications of neutron production and flux monitoring techniques; and progress in the construction of a new accelerating tube and instrumentation for neutron time-of-flight work. Good measurements were secured for the reactions $^{15}N(n,d)^{14}C$, $^{14}N(n,t)^{12}C$ and $^{32}S(n,d)^{31}P$, and exploratory results obtained for $^{34}S(n,d)^{33}P$, $^{93}Nb(n,a)^{90}Y$, $^{127}I(n,d)^{126}Te$ and $^{15}N(d,n)^{14}C$ at a second neutron energy (using the kinematic variation with laboratory angle). Appropriate modifications of apparatus are well advanced for work on the $n-^3H$ interaction, d + d neutron polarization and (n,α) reactions of ^{14}N and ^{16}O. (auth)

14534 (ORNL-CPX-2) NUCLEAR CROSS SECTIONS FOR CHARGED-PARTICLE INDUCED REACTIONS — Ni, Cu. F. K. McGowan, W. T. Milner, and H. J. Kim, comps. (Oak Ridge National Lab., Tenn.). Sept. 1964. Contract [W-7405-eng-26]. 513p. Dep.; Free(ORNL).

Data are presented in tables and graphs of the cross sections of Ni and Cu, and of the isotopes of these elements, for reactions initiated by charged particles (ranging from protons to ^{22}Ne nuclei). (T.F.H.)

14535 (ORNL-P-813) SPECTRA OF GAMMA RAYS PRODUCED BY INTERACTION OF ~160 Mev PROTONS WITH Be, C, O, Al, Co, AND Bi. W. Zobel, F. C. Maienschein, and R. J. Scroggs (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 20p. (CONF-720-10). Dep.(mn); $1.00(cy), 1(mn) OTS.

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Measurements were made of the gamma rays produced in several materials by 160-Mev protons. The targets were chosen to cover a wide range in Z and included Be, C, O, Al, Co, and Bi. The measured gamma energies and cross sections are tabulated. (C.E.S.)

14536 (ORNL-P-848) DIFFERENTIAL CROSS SECTIONS BY FLIGHT-TIME SPECTROSCOPY FOR PROTON PRODUCTION IN REACTIONS OF 160-Mev PROTONS ON NUCLEI. R. W. Peelle, T. A. Love, N. W. Hill, and R. T. Santoro (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 17p. (CONF-720-4). Dep.(mn); $1.00(cy), 1(mn) OTS.

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Proton reactions on nuclei are studied at 160 Mev, with targets of H_2O, D_2O, Be, Al, C, Co, and Bi. The relevance of the results to the shielding requirements for space vehicles against primary cosmic protons in this energy range is discussed. (T.F.H.)

14537 (PAN-540/1) THE RELATIVE COMPETITIONS OF THE COMPOUND AND DIRECT PROCESSES IN THE $Si^{29}(n,\alpha)Mg^{26}$ REACTION AT NEUTRON ENERGIES AROUND 14 Mev. M. Jaskóła, I. Turkiewicz, J. Turkiewicz, and F. Gradzki (Polish Academy of Sciences, Inst. of Nuclear Research, Warsaw). July 1964. 13p. Dep.

The nuclear reaction $^{29}Si(n,\alpha)^{26}Mg$ was studied by bombarding a silicon detector with fast neutrons. The excitation function for the ground state transition was measured in the neutron energy range 13.41 to 14.96 Mev. The relative contributions of the direct and compound processes was estimated from the cross section probability distribution. (auth)

14538 (TID-20387) ANGULAR DISTRIBUTION OF γ-RAYS PRODUCED BY FAST NEUTRON INELASTIC SCATTERING IN Fe. R. W. Benjamin, D. O. Nellis, I. L. Morgan, and W. E. Tucker (Texas Nuclear Corp.,

Austin, Tex.). [1959]. Contract AT(40-1)-2791. 21p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Angular distributions of γ rays produced by the (nn'γ) reaction in Fe were measured at incident neutron energies ranging from 900 kev to 4 Mev. Data were taken from θ = 20 to 135°, with an average angular resolution of ±6°. The γ rays were observed with a 2-crystal anticoincidence spectrometer, using conventional time-of-flight techniques where applicable. Some of the data were compared with theoretical angular distributions derived from Satchler theory. (auth)

14539 (TID-21627) THRESHOLDS FOR NEUTRON-INDUCED REACTIONS. R. J. Howerton, Donald Braff, W. J. Cahill, and Nanette Chazan (California. Univ., Livermore. Lawrence Radiation Lab.). May 1964. Contract W-7405-eng-48. 342p. Dep.(mn); $7.00(cy), 10(mn) OTS.

Thresholds are tabulated for nuclear reactions initiated by neutrons, protons, deuterons, tritons, ^{3}He nuclei, alpha particles, and photons. (T.F.H.)

14540 (TID-21629) ANGULAR DISTRIBUTION COEFFICIENTS FOR ELASTIC SCATTERING OF NEUTRONS. C. P. Altamirano and S. T. Perkins (Aerojet-General Nucleonics, San Ramon, Calif.). Dec. 1964. Contract AT(10-1)-880. 187p. (AN-1321). Dep.(mn); $5.00(cy), 4(mn) OTS.

The results of an analysis which utilized the experimental differential cross section for elastic scattering of neutrons are presented. The calculated quantities for all materials were the elastic scattering cross section, the average logarithmic energy decrement per collision, and the Legendre expansion coefficients. The neutron energy range was approximately from 0.1 to 14 Mev. These parameters were presented graphically as a function of neutron energy when sufficient data were available. For materials in which this was not the case, the results are presented in tabular form. (auth)

14541 (UR-875-8) THE $C^{13}(\alpha,n)O^{16}$ REACTION BETWEEN 5.9 AND 8.4 Mev. V. K. Deshpande and H. W. Fulbright (Rochester, N. Y. Univ.). Feb. 11, 1964. Contract AT(30-1)-875. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The $^{13}C(\alpha,n)^{16}O$ reaction leading to the ground state of ^{16}O was studied between 5.9 and 8.4 Mev. Strong resonance structure is observed in the O^{0} excitation curve with peaks at 6.58, 7.02, 7.42, and 8.26 Mev. The angular distributions obtained at these four energies are analysed on the basis of the compound nucleus formation process. Levels of ^{17}O with $J \geq 5/2, 5/2, 3/2, 3/2$ seem to contribute at the four respective peak positions. (auth)

14542 (ANL-Trans-156) A SIMPLE PRESENTATION OF THE ANGULAR DISTRIBUTION OF DECAY PRODUCTS FROM A COMPOUND NUCLEUS AFTER A DIRECT NUCLEAR REACTION. V. M. Strutinskii (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii. Institut Atomnoi Energii im. I. V. Kurchatova, Moscow). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Preprint IAE-733. 1964. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

The classical model of the angular distribution of the products of the decay or fission of a compound nucleus in mixed nuclear reactions, where the compound nucleus is formed after a direct nuclear reaction is discussed. Due to the absence of interference, the angular distribution of the decay products of the compound nucleus represents a packet of the probability distributions. For the same reason the initial state of the compound nucleus (i.e. the final state for a direct process) can be also treated by means of a certain probability distribution. There results essentially a classical problem. The applicability of the classical presentation depends on the width of the packet which is determined by the parameters $\Delta m/\mathfrak{l}$, $\Delta\mathfrak{l}/\mathfrak{l}$, etc. At $\Delta m/\mathfrak{l} \sim 1$ the classical calculation is sufficiently accurate for all angles, if $(\Delta m/\mathfrak{l}) \ll 1$ but $\Delta\mathfrak{l}/\mathfrak{l} \sim 1$ for $\sin\vartheta \gtrsim 1/\mathfrak{l}$. A very good accuracy even for $\mathfrak{l}$ of the order 1 is obtained if in the classical expressions substitutions of the type $j \rightarrow \sqrt{j(j+1)}$ are carried out. The scattering of states can originate from internal causes, e.g. from thermal fluctuations at the evaporation, averaging over the initial states of the particles or by other reasons. (auth)

14543 THE OVERLAP INTEGRAL IN REACTIONS INVOLVING TRITONS OR HELIONS-3. A. Sandulescu and O. Dumitrescu. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 21-35(1964). (In Rumanian)

Single-particle effects play an important role in low-energy nuclear reactions; calculation of width on the basis of nuclear models for the emission of one or more nucleons makes it possible to estimate the magnitude of these effects. The calculations require only determination of the overlap integral between the spatial wave function of the nucleons participating in the reaction, the product of orbital momentum, and the wave functions of the emitted particle. Continuing a previous study of the emission of triton and helion-3 of the senior author (Revue de Physique 5: 427(1960)), it was assumed that the common potential of the shell model is a harmonic potential. Using the symmetry properties of the oscillator function, a specific expression was derived for the overlap potential of reactions involving ^{3}H and ^{3}He nuclei, including in derivation the overlap integral of α particles. The approximations made are considered acceptable for long-lived excited states. (TTT)

14544 THE SCATTERING OF NUCLEONS AT LOW ENERGIES, CONSIDERED FROM THE VIEWPOINT OF THE CURRENT STRUCTURAL MODELS OF THE NUCLEUS. PART I. A. Berinde (Univ. of Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 15: 61-124(1964). (In Rumanian)

The rapid growth of the theory of nuclear reactions during the past decade is largely due to the development of models of the structure of the nucleus. The term "model" is used to designate simplifying physical or mathematical assumptions, which allow characteristics of the nuclear structure to be calculated with a given precision. An attempt was made to correlate the various nuclear reaction models with the nuclear structure models indicating how the structure affects the various features of the reaction mechanism, such as cross section, angular distribution, excitation function, etc. The optical model, the shell model, the formation of compound nuclei, their desintegration, and elastic scattering phenomena are discussed, together with the Fermi gas model, the thermodynamic model, the excited medium model, the superfluidity model, and others. The general theory of nuclear reactions is reviewed, explaining elastic and inelastic scattering phenomena and defining the concept of the reaction cross section. The mechanism involved in the formation of compound nuclei and the theory of strong interactions are critically examined. Attention is given to the resonant states and to the angular correlation $(p,p'\gamma)$ and $(n,n'\gamma)$ in compound nucleus reactions. (Review article, 43 references). (TTT)

14545 ON THE AVERAGE NUCLEAR POTENTIAL. A. Y. Abul-Magd and M. El-Nadi (Atomic Energy Establishment, Cairo). Atomkernenergie, 9: 425-6(Nov.-Dec. 1964).

The average nuclear potential is calculated in the Hartree-Fock approximation for infinite nuclear matter. It was found that a static Gaussian two-nucleon potential with parameters required to explain low energy scattering data and mixed Wigner and Majorana forces with weights 0.19 and 0.81 respectively can reproduce the correct velocity dependence or nonlocality of the nucleon-nucleus potential. (auth)

14546 DELAYED PROTONS FOLLOWING ^{21}Mg AND ^{25}Si DECAY. R. McPherson and J. C. Hardy (McGill Univ. Montreal). Can. J. Phys., 43: 1-11(Jan. 1965).

The delayed-proton precursors ^{21}Mg and ^{25}Si were produced by proton bombardment of targets of sodium, magnesium, aluminum, and silicon dioxide in the internal beam of the synchrocyclotron. Half lives of 118 ± 4 and 225 ±

6 msec respectively were measured, and a spin-parity assignment of $(5/2)^+$ was made to the ground state of ^{21}Mg. Strong lines in the delayed-proton spectra were attributed to decay of the expected first T = 3/2 states in ^{21}Na and ^{25}Al, fed by superallowed β transitions from the respective precursors ^{21}Mg and ^{25}Si. (auth)

14547 LIFETIMES OF THE LOW-LYING LEVELS OF ^{20}Ne. H. C. Evans, M. A. Eswaran, H. E. Gove, A. E. Litherland, and C. Broude (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Phys., 43: 82-95(Jan. 1965). (AECL-2126)

The lifetimes of the 1.63-, 4.25-, 4.97-, and 5.63-Mev levels in ^{20}Ne were measured by the Doppler shift attenuation method. The lifetimes in picoseconds are 1.23 ± 0.12, 0.134 ± 0.012, 4.8, and 0.35 ± 0.075 respectively. The reduced widths in Weisskopf units for the 1.63-, 2.62-, 3.34-, and 4.00-Mev gamma transitions, together with the gamma multipolarities, are 17.6 (E2), 15.1 (E2), 7.4×10^{-6} (E1), and 4.7×10^{-6} (E1). (auth)

14548 ELASTIC SCATTERING OF ALPHA PARTICLES BY OXYGEN FOR INCIDENT ENERGIES BETWEEN 7.2 AND 8.5 Mev. G. J. McCallum and A. J. Ferguson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 43: 111-21(Jan. 1965). (AECL-2129)

Angular distributions of α particles elastically scattered by ^{16}O, obtained at 12 energies between 7.4 and 8.5 Mev, are presented together with the yield of scattered α particles measured by fixing the detectors at a given angle and varying the energy of the incident particles. Four such excitation curves in the energy range 7.2–8.4 Mev are presented. Resonances are observed at energies 7.32, 7.66, 7.89, and 8.28 Mev. Tentative spin and parity assignments of 4+ and 2+ are obtained for the 7.89- and 8.28-Mev resonances. (auth)

14549 ANGULAR DISTRIBUTION OF ALPHA PARTICLES FROM THE DECOMPOSITION REACTIONS OF HELIUM-5. Georges Bruno, Jacques Decharge, Andre Perrin and Georges Surget (Commissariat a l'Energie Atomique, Montrouge, France). Compt. Rend., 259: 3995-8(Nov. 30, 1964). (In French)

The angular distribution of the alpha particles from the decay of the ground level of ^{5}He was studied. A distribution of the form $\sigma(\theta) = \sigma(0^0)$ $(1 + A \sin^2 \theta)$ with A = 3 ± 1 was found, in agreement with the angular moment $J = 3/2^-$ attributed to this level. (tr-auth)

14550 A STATISTICAL MODEL OF U-235 FISSION. E. Erba, U. Facchini, E. Saetta-Menichella, and F. Tonolini (CISE, Milan and Universita, Milan). Energia Nucl. (Milan). 12: 26-32(Jan. 1965).

A statistical analysis of the fission mechanism of the ^{236}U is discussed. The basic formulas used were introduced by Ericson. Computations are presented of total kinetic energy and mass distributions of the final fragments at different excitation energies of the compound nucleus, number of neutrons emitted by the single fragments, and fission widths of ^{236}U compound nucleus for excitation energies from zero (spontaneous fission) to 12.4 Mev, corresponding to ^{235}U (n,f) induced by 6 Mev neutrons. The most striking aspects of the fission are well accounted for. (auth)

14551 THE HYPERFINE STRUCTURE IN Fe-57 USING MÖSSBAUER EFFECT. Tien-fang Yang and Shou-yih Wang. Ho Tsu K'o Hsueh, 4: 17-34(Feb. 1964).

The hyperfine structure of ^{57}Fe was observed using the Mössbauer effect. The 14.4-kev gamma ray from the first excited state of ^{57}Fe was detected by a proportional counter. The hyperfine spectrum observed with a stainless steel source and a natural iron absorber exhibits six recoilless resonance absorption lines of ^{57}Fe with intensity ratios of approximately 3:2:1:1:2:3. The magnetic moments calculated from the splitting are 0.0925 and 0.1555 nm for the ground and first excited states, respectively. The chemical shift between iron and stainless steel was negligible within the experimental accuracy. (D.C.W.)

14552 ANGULAR CORRELATION OF SUCCESSIVE GAMMA-RAYS. Ying-chuan Yang and Tsing-yih Wang (National Tsing Hua Univ., China). Ho Tsu K'o Hsueh, 4: 35-8(Feb. 1964).

The results of a study of the angular correlation of successive gamma rays of ^{60}Co are presented. It is concluded that the successive gamma rays belong to quadrupole-quadrupole transitions 4(2)2(2)0. (D.C.W.)

14553 THEORETICAL AND EXPERIMENTAL RADIATION TRANSITIONS IN DEFORMED YTTERBIUM-173 NUCLEI. O. D. Kovrigin, G. D. Latyshev, and G. A. Londarenko. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 51-9(Jan.-Apr. 1964). (In Russian)

A double-focusing magnetic spectrometer was used to measure the spectrum of internal conversion electrons from the decay of the excited states of ^{173}Yb that result from the K-capture decay of ^{173}Lu. The source was obtained by separating chromatographically the lutetium formed when a tantalum target was irradiated with 660-Mev protons. Over a period of 4 months the spectrum was measured from H_0 = 400 to 3500 gauss-cm with a resolution of ±0.3% in general. Intense internal conversion lines were measured with a ±0.1% resolution, and agree with previous data. New conversion lines were found at E_e = 161.6, 173.0, 352.0, and 402.8 kev, corresponding to gamma transitions of E_γ = 223, 233.8, and 413.3 kev. A level diagram is presented for ^{173}Yb based on the supposition that the 413.3-kev level is rotational with a spin of $J = 9/2$ ($K = 7/2$). The measured gamma transition probabilities to the first two rotational levels agree with theoretical predictions by Nilsson to within a factor of 4. However, the measured probability of El decay to the ground state is less than the calculated value by a factor of 500. The decrease can be explained by viewing the strongly deformed nucleus as a mixture of states with different values of K quantum number. (TTT)

14554 SYSTEMATICS OF E2 TRANSITION IN EVEN-EVEN NUCLEI. D. K. Kaipov and A. K. Zhetbaev. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 73-8 (Jan.-Apr. 1964). (In Russian)

The lifetime τ and energy E of the excited E2 states in even-even nuclei were plotted as a function of the number of nucleons in nuclei from A = 12 (^{12}C) to 240 (^{240}Pu). A plot of lg E versus lg $(1/\tau)$ gives a straight line described by the following equation: lg E = (0.28258 ± 0.00007) lg $(1/\tau)$ − (0.27 ± 0.04). Here E is the energy in Bev and τ is the lifetime in sec. A plot of lg $(1/\tau)$/lg E versus the atomic weight A can be described by the following formula: lg $(1/\tau)$ = (3.75 ± 0.04) lg E + (127150 ± 9) 10^{-8} A lg E. Discontinuities can be observed in the region near nuclei having magic numbers. A formula of the type lg B (E2) = a lg E + b is obtained, when the reduced probability B is plotted against lg E. A plot of B versus the atomic weight A shows a sharp decrease in lg B in the region of magic nuclei. (TTT)

14555 NUCLEAR REACTIONS WITH A HIGH-ENERGY NEUTRINO. PART I. S. V. Izmailov and L. I. Smirnov (Gertsen State Pedagogical Inst., Leningrad). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 11-15(1964). (In Russian)

A general formula is obtained for the energy and angular distributions of μ mesons or positrons in nuclear reactions of the type $\bar{\nu}_{\mu,e} + A \rightarrow A^* + n + \mu^+(e^+)$, where n is the neutron knocked out from the nucleus by direct process. (tr-auth)

14556 YIELDS FROM DEUTERON NUCLEAR REACTIONS. V. V. Suvorov, K. V. Shitikova, and A. K. Shtoltz (Kirov Ural Polytechnic Inst., USSR). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 6, 150-9(1964). (In Russian)

Calculations were carried out of the yield of the reaction ^{26}Mg(d,p)^{27}Mg, of the excitation curves and yields of (d,n) and (d,2n) reactions on ^{46,47,48,49,50}Ti, ^{50,52,53,54}Cr, and ^{54,56,57,58}Fe, and the excitation function of the reaction ^{24}Mg(d,α)^{22}Na. Tables are given of results for deuteron energies from 5 to 20 Mev. (M.J.T.)

14557 EXPONENTIAL ENSEMBLE FOR RANDOM MATRICES. Burt V. Bronk (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 6: 228-37(Feb. 1965).

Using the ideas of information theory, it is pointed out that the Gaussian ensemble for random Hermitian matrices can be characterized as the "most random" ensemble of these matrices. Pursuing the same characterization for positive matrices, the exponential ensemble is defined. Transforming to a representation of eigenvectors and eigenvalues, the joint distribution function for the eigenvalues of positive Hermitian matrices is found for this ensemble. The asymptotic single-level density formula is derived, using a semiclassical model. It is found that the density is convex from below over most of the domain of eigenvalues. Since this is similar to the exponential dependence expected for nuclear spectra, the density is examined in a region near the level taken to correspond with the lowest nuclear level. It turns out, however, that the density is concave from below near this level, and that a large number of levels are contained in this concave region. Hence, the exponential ensemble does not fairly represent nuclear energy levels, at least in this region. Various changes are made in the measure on the matrix ensemble to determine to what extent the level density depends on this measure. It is seen that the level density graph retains a characteristic shape for a wide variety of measures. The relation of the limiting behavior of the level density for positive matrices to the semicircle law is noted. (auth)

14558 STUDY OF LEVELS OF ^{7}Be (AT 6 TO 10 Mev) BEGINNING WITH EXPERIMENTAL RESULTS OF THE ^{6}Li(p,α)^{3}He REACTION FROM 100 kev TO 3 Mev. H. Beaumevieille, J. P. Longequeue, N. Longequeue, and R. Bouchez (Universite, Grenoble, France and Centre d'Etudes Nucleaires, Grenoble, France). J. Phys. (Paris), 25: 933-42(Nov. 1964). (In French)

Experimental results on the reaction ^{6}Li(p,α)^{3}He from 100 kev to 3 Mev can be interpreted by the compound nucleus theory with the following levels of ^{7}Be: $3/2^{-}$, 5.9 Mev; $3/2^{+}$, 6.2 Mev; $5/2^{-}$, 7.18 Mev; and another level which should be $1/2^{+}$ or ^{4}P (9.5 Mev). (auth)

14559 ENERGY OF COHERENCE OF THE ^{29}Si NUCLEUS. Marcel Cadeau, Daniel Didier, Bernard Duchemin, H. Guy Mouilhayrat, and Pierre Thouvenin (Commissariat a l'Energie Atomique, Paris). J. Phys. (Paris), 25: 943-5(Nov. 1964). (In French)

The behavior of the ^{28}Si(n,α)^{25}Mg reaction cross-section was studied for incident neutrons from 14.37 to 14.57 Mev. The neutrons were obtained from the T(d,n)^{4}He reaction. The deuterons were accelerated by a Van de Graaff accelerator and were selected by an analyzing magnet; their energy was measured by using nuclear magnetic resonance. The energy spread of the neutrons received by the detector was less than 22 kev. The correlation functions relating to the best defined levels and to the sum of several levels were calculated. From the data, a coherence energy was obtained lower than that found previously for the same compound nucleus at the same excitation energy, but with a larger incident energy spread. (auth)

14560 ENERGY LEVELS OF ^{21}Ne. Masachiyo Sato (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), 25: 951-6(Nov. 1964). (In French)

The lower levels of ^{21}Ne were analyzed in the nuclear jj-coupling shell model, using harmonic oscillator wave functions and central Gaussian interaction with the exchange character of Rosenfeld. Energy levels of the pure configuration $(5/2)^{5}$ were examined at first, by the method of the coefficients of fractional parentages. A set of principles was presented with the purpose of selecting the configurations which should be taken into account for the analysis of lower levels of nuclei in d-s shells, and energy matrices for three selected configurations — $(5/2)^{2}(1/2)^{3}$, (5/2) (3/2) $(1/2)^{3}$, and $(1/2)^{3}(3/2)^{2}$ — were constructed and diagonalized. The results give correctly the anomalous spin $3/2$ of the ground state and agree with experimental data for excited levels. (auth)

14561 STUDY OF GAMMA-GAMMA CASCADES IN THERMAL NEUTRON CAPTURE BY ISOTOPES ^{55}Mn, ^{56}Fe, ^{59}Co, AND ^{199}Hg. P. Carlos, H. Nifenecker, J. Fagot, and J. Matuszek (Centre d'Etudes Nucleaires, Saclay, France). J. Phys. (Paris), 25: 957-60(Nov. 1964). (In French)

The gamma-gamma cascades following neutron capture in ^{55}Mn, ^{56}Fe, ^{59}Co, and ^{199}Hg were studied using a Hoogenboom circuit with two NaI(Tl) crystals. Results are presented on gamma-gamma cascades which go from the capturing state to the ground state. (auth)

14562 CALORIMETRIC DETERMINATION OF THE MEAN BETA ENERGY OF ^{198}Au. M. Lecoin and J. Robert (Universite, Paris). J. Phys. (Paris), 25: 975-8(Nov. 1964). (In French)

The average beta energy of ^{198}Au was determined by a calorimetric method. The result (287 ± 20 kev) seems to be lower than the value obtained by integration of the beta spectrum. (auth)

14563 APPLICATION OF THE HOOGENBOOM METHOD FOR STUDY OF GAMMA-GAMMA CASCADES. P. Carlos, H. Nifenecker, R. Samama, and J. Fagot (Centre d'Etudes Nucleaires, Saclay, France). J. Phys., Phys. Appl. (Paris), 25: 203A-7A(Nov. 1964). (In French)

An experimental facility installed near the Saclay reactor (EL-3) for the study of gamma rays from thermal neutron capture is described. A sum spectrometer of the Hoogenboom type, using two NaI(Tl) crystals (5 × 4 in.) in association with two photomultipliers, was tested using ^{60}Co and ^{22}Na. The results are discussed. (D.C.W.)

14564 ELASTIC SCATTERING OF NEUTRONS FROM Al, Si, P, S AND Zn. Shigeya Tanaka (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 19: 2249-59 (Dec. 1964).

The differential cross sections for elastic scattering of neutrons from Al, Si, P, S, and Zn were observed by means of the time-of-flight technique in an energy range of 3.5 to 4.8 Mev and over angles of scattering from 15 to 160°. The differential cross sections for even-Z element, Si, S, and Zn, were compared with those calculated on the basis of an optical potential which was similar to the Bjorklund and Fernbach potential, the depth of the potential being 50 Mev for the real part and 9 Mev for the imaginary part. In the calculation the compound-elastic scattering was calculated by using the penetrability which was computed with the same potential, and this was added to the shape-elastic scattering. Agreement is fairly good for Si and S except for the case of the lowest energy in the energy range of the experiment. For Zn the calculated values at the second maximum of the differential cross sections are about two times as high as those observed. (auth)

14565 FREQUENCY SHIFT IN MAGNETIC TRANSITIONS BETWEEN HYPERFINE LEVELS OF $^{2}P_{\frac{1}{2}}$ STATES OF Cs^{133}. A. Faist, E. Geneux, and S. Koide (Univ. of Geneva). J. Phys. Soc. Japan, 19: 2299-2305(Dec. 1964).

By using the double resonance method, transitions F = 5 → F = 4 and F = 3 → F = 2 are measured for 7 $^{2}P_{\frac{1}{2}}$ and 8 $^{2}P_{\frac{1}{2}}$ states of the ^{133}Cs atom (I = $7/2$). Frequency shifts proportional to the input power are observed. In order to compare with the experiment, the theory of frequency shift due to radiation is generalized to the case of transitions between degenerate levels. The result of the calculation is in good agreement with the experimental data. (auth)

14566 ENERGY DISTRIBUTION OF PHOTO-PROTONS FROM Al^{27}, Ni^{58}, AND Cu^{63}. Masayoshi Masuda (Tokyo Inst. of Tech.), Motoo Kondo, Shigeru Takeda, Masayuki Okumura, and Juzo Ookuma. J. Phys. Soc. Japan, 19: 2339-40(Dec. 1964).

The energy distribution of protons from the (γ,p) reaction on ^{27}Al, ^{58}Ni, and ^{63}Cu was investigated by means of solid state detectors. The isotopes, in the form of foils, were placed at the center of a precisely collimated bremsstrahlung beam from a 24-Mev betatron. The bremsstrahlung energies were 20, 22, and 17 Mev, for ^{27}Al, ^{58}Ni, and ^{63}Cu, respectively. (C.E.S.)

14567 CONVERSION COEFFICIENT AND MULTIPOLE ORDER DETERMINATION OF THE RADIATION EMITTED BY THE FIRST EXCITED STATE OF Li^{7} BY MEANS OF A CLOUD CHAMBER. A. Kriester (Friedrich-Schiller-

Universität, Jena, Ger.). Kernenergie, 7: 748-53(Nov. 1964). (In German)

A method by which the conversion coefficient of the first excited Li_γ state was experimentally determined to be $N_e/N_\gamma = (7.3 \pm 1.1) \times 10^{-7}$ is described. A "slow" cloud chamber was used with preparates containing Be_γ in thin layers produced by deuteron bombardment of LiF from a 1 megavolt cascade generator. The conversion of Be_γ is shown schematically and the conversion coefficient was also calculated analytically and numerically for order Z = 3, a dipole, quadrupole and octupole. The fabrication of the Be_γ preparates is described, along with the experimental apparatus containing a target with water-cooling coils. Two methods were available for determining the coefficient: the "absolute" one requiring the knowledge of the "practical" life time of the Be_γ traces, and the much less accurate "relative" one. Analytical and experimental results are compared. Thirteen bibl. ref. are listed. (OTS)

14568 THE MEASUREMENT OF THE DOSE-RATE OF ARGON IN A RADIOACTIVE GAS VOLUME. G. Hasl (Universitat, Frankfurt am Main). Kerntechnik, 7: 18-22(Jan. 1965). (In German)

For the measurement of the dose rate of ^{41}Ar, argon was activated in the reactor FRF. The produced ^{41}Ar was mixed with the air in the Frankfurt Cockcroft-Walton-Accelerator Hall. The activity concentration was measured with a calibrated ionization chamber. The dose rates were determined with a calibrated β counter and a calibrated γ scintillation counter. For the extrapolation on the semi-infinite room, approximative calculations were used. Finally, the contributions of the γ and β dose rate to the overall dose rate at different geometric arrangements of the radioactive gas are discussed. (auth)

14569 EVALUATION OF THE REDUCED α-CLUSTER WIDTH IN TRANSITIONS TO HOLE-EXCITED FINAL STATE. Peter Beregi. Magy. Tud. Akad. Kozp. Fiz. Kut. Inst. Kozlemen., 12: 407-24(1964). (In Hungarian)

By using the independent particle shell model c.f.p-s and taking spurious states into account, the reduced width is evaluated for α transitions, assuming the initial nucleus to be in the ground state and the final nucleus at an excited hole level. (auth)

14570 ENERGY DISTRIBUTION OF FISSION FRAGMENTS FROM U-233, U-234, Pu-239. Tibor Nagy, Istvan Pavlicsek, and Laszlo Nagy. Magy. Tud. Akad. Kozp. Fiz. Kut. Inst. Kozlemen., 12: 439-45(1964). (In Hungarian)

The energy distribution of fission fragments from thermal-neutron induced fission of ^{233}U, ^{235}U, and ^{239}Pu was measured, employing a gridded ionization chamber. The results of the measurements, performed as a preliminary to the experimental investigation of ternary fission, are in good agreement with previous experiments. (auth)

14571 NEUTRON INTERACTIONS WITH U^{238} AND Th^{232} IN THE ENERGY REGION 1.6 Mev TO 7 Mev. R. Batchelor, W. B. Gilboy, and J. H. Towle (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Phys., 65: 236-56(1965).

The fast neutron interactions of ^{238}U and ^{232}Th in the range 1.6 to 7 Mev were studied by measuring the secondary neutron spectra as a function of angle and bombarding energy with a time-of-flight spectrometer. The non-elastic spectra were observed to have structure at 2 Mev, but became continuous at higher energies. The differential elastic cross-sections for ^{238}U agree well with previous work and were compared with optical model calculations based on a non-local potential. The continuous non-elastic spectra were fitted with formulas of the type $N(E) = AE \exp(-E/T) + BE^{\frac{1}{2}} \exp(-bE)$, where the first and second terms represent the evaporation and post-fission neutrons, respectively. For all measurements good agreement between the values of $\eta_{\sigma_{non\text{-}elastic}}$ obtained directly from the non-elastic spectra and the values obtained from the relations $\eta = 1 + [(\overline{\nu} - 1)\sigma_{nF} + \sigma_{n2n} - \sigma_{n\gamma}/\sigma_{non\text{-}el}]$ and $\sigma_{non\text{-}el} = \sigma_T - \sigma_{el}$, was obtained. (auth)

14572 THE FISSION CROSS SECTION OF Pu^{241} FROM 0.01 ev TO 3 kev. G. D. James (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 65: 353-68(Apr. 1965). (AERE-R-4597)

The fission cross section of ^{241}Pu was measured from 0.01 ev to 3 kev by the time-of-flight method. Below 11 ev the data are in fair agreement with the cross section given by the multilevel parameters of Simpson and Moore. A multilevel analysis of the cross section from 11 to 17 ev was carried out. The errors in the mean fission cross section are discussed. (auth)

14573 BETA DECAY THEORY USING EXACT ELECTRON RADIAL WAVE FUNCTIONS. IV. INDUCED EFFECTS. Wolfgang Buehring and Lothar Schuelke (Universitat, Heidelberg). Nucl. Phys., 65: 369-81(Apr. 1965).

Beta decay formulas derived in previous papers are reinterpreted on the basis of a quite general V-A interaction, which takes into account all effects induced by the strong interaction. As an example, the induced pseudoscalar interaction is investigated in some detail. (auth)

14574 DIRECT REACTION ANALYSIS OF THE $F^{19}(p,\alpha_0)O^{16}$ REACTION. K. L. Warsh and Steve Edwards (Lockheed Georgia Co., Marietta, Ga.). Nucl. Phys., 65: 382-400(Apr. 1965).

Thirty-two angular distributions of the $^{19}F(p,\alpha_0)^{16}O$ reaction over a 23-Mev range were analyzed using a plane-wave direct reaction theory incorporating pick-up and exchange pick-up (or heavy-particle stripping) coherently mixed. The results of this analysis indicate that the reaction proceeds predominantly by a direct reaction mechanism, but that compound nucleus contributions can not be ignored at certain energies. Only partial success in obtaining a fit to the extreme backward peak at 11-Mev proton bombarding energy, plus the fact that the poorest fits are obtained for other angular distributions with large backward peaking, indicate that other mechanisms than first-order exchange effects are possibly contributing to the backward peaking observed. (auth)

14575 EXCITED STATES OF NON-AXIAL ODD-MASS NUCLEI. V. V. Pashkevich and R. A. Sardaryan (Moscow State Univ.). Nucl. Phys., 65: 401-18(Apr. 1965).

The spin sequence and excited state energies of odd-mass nuclei are calculated without separating the states into single-particle and collective excitations. The results of the theory are compared with experiment. (auth)

14576 TOTAL CROSS SECTIONS OF V, In, I, AND Bi FOR 3.2-5.2 Mev NEUTRONS. F. Manero (Junta de Energia Nuclear, Madrid). Nucl. Phys., 65: 419-25(Apr. 1965).

The total neutron cross sections of V, In, I and Bi were measured by the transmission method for neutrons of energies between 3.2 and 5.2 Mev. Neutrons of about ±30 kev energy spread were produced by bombarding a heavy ice target with deuterons. Broad resonances were observed in all nuclei that suggest fluctuations in the level density of the compound nucleus. (auth)

14577 THE ROTATION BANDS $K = 0^-$ AND $K = 1^-$ IN Pa-234. A. G. De Pinho and J. Picard (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., 65: 426-32(Apr. 1965). (In French)

The ^{234}Pa nucleus is interpreted as a rotator plus two odd nucleons. The energies and wave functions of the various states of the K = 0 and K = 1 rotational bands arising from the coupling of two $\Omega = \frac{1}{2}$ Nilsson orbits are found by calculating and numerically diagonalizing the Hamiltonian matrix. (auth)

14578 THE (d,α) REACTION ON N^{15} AND O^{16} IN THE DEUTERON ENERGY RANGE 1-2.5 Mev. N. A. Mansour, H. R. Saad, Z. A. Saleh, E. M. Sayed, I. I. Zaloubovskii, and V. I. Gontchar (Atomic Energy Establishment, Cairo). Nucl. Phys., 65: 433-40(Apr. 1965).

Excitation functions and angular distributions for the first two α groups from the $^{15}N(d,\alpha)^{13}C$ reaction and for the first α-group from the $^{16}O(d,\alpha)^{14}N$ reaction were observed. For the first reaction, a broad maximum in the excitation curve was observed for both α-groups at the deuteron energy of 1.6 to 1.8 Mev. Slight irregularities were observed in the excitation function for α-particles of the second reaction at 1.2, 1.9, 2.1 and 2.4 Mev. Angular distributions of α-

particles from the $^{15}N(d,\alpha)^{13}C$ reaction show a mixing between the compound nucleus and direct interaction mechanisms. Angular distribution of the first α-group from the $^{16}O(d,\alpha)^{14}N$ reaction are typical of the compound nucleus mechanism. Differential cross sections for all α-groups are given in a wide energy range. (auth)

14579 RE-INTERPRETATION OF SOME EXPERIMENTAL RESULTS ON M1 PENETRATION MATRIX ELEMENTS IN Tl^{203}, Tl^{201}, AND Ta^{181}. T. R. Gerholm, B. G. Pettersson, and Z. Grabowski (Univ. of Stockholm). Nucl. Phys., 65: 441-53(Apr. 1965).

The recent discovery of a sign error in the theory of directional correlations involving conversion electrons, leading to a sign reversal for the interference particle parameters, implies drastic changes in the interpretations of experimental results previously obtained. Re-interpretations of experimental studies of certain magnetic dipole transitions in ^{203}Tl, ^{201}Tl and ^{181}Ta are presented. It is shown that consistent solutions exist within the framework of the corrected theory. Moreover, there is now good agreement between theoretically estimated and experimentally determined values for the parameter λ for all magnetic dipole transitions investigated; λ is defined as the ratio of the penetration matrix element and the gamma-ray matrix element. The sign reversal leads to λ values entirely different from those previously obtained. However, the main conclusions drawn in the previous publications remain valid; nuclear structure dependent penetration matrix elements are found to be competitive in the case of retarded M1 transitions and affect the conversion-electron directional correlations as well as the internal conversion coefficients. For allowed M1 transitions, however, no such effects caused by the presence of penetratrion matrix elements can be noticed. All of the λ values are in accordance with what is to be expected on theoretical grounds. The importance of the knowledge of the M1 penetration matrix element for the interpretation of the recent experiment on parity-violating contributions to the 482 kev transition in ^{181}Ta is considered. (auth)

14580 NON-EXISTENCE OF DYNAMIC CONTRIBUTIONS TO THE 412 kev E2 CONVERSION PROCESS IN Hg^{198} DEMONSTRATED BY A NEW EXPERIMENTAL METHOD. B.-G. Pettersson, L. Holmberg, and T. R. Gerholm (Univ. of Stockholm). Nucl. Phys., 65: 454-65(Apr. 1965).

An experimental technique for the study of the internal conversion process was developed and applied for an investigation of the 412-kev, E2 transition in ^{198}Hg. The new method implies an indirect and accurate determination of the particle parameter $b_2(E2)$ as well as of the internal conversion coefficient $\alpha_K(E2)$. Both quantities are derived from an experimental measurement of the $b_4(E2)$ particle parameter. It is shown that the accuracy in the value for $b_2(E2)$ thus obtained is considerably higher than would be possible on the basis of a direct measurement of $b_2(E2)$. On the basis of the theory of Green and Rose the parameter $b_2(E2)$, when accurately determined, may be used to derive experimental values for the dynamic contributions to the radial matrix element R_{-3} and R_{+2} governing the E2 conversion process. These contributions were found to be negligible within narrow limits of experimental errors. Finally, $\alpha_K(E2)$ is calculated using the experimentally determined radial matrix elements. The value for $\alpha_K(E2)$ of the 412-kev, E2 transition in ^{198}Hg thus obtained becomes $\alpha_K(\text{present exp}) = 308 \pm 9 \times 10^{-4}$, in perfect agreement with the theoretical values obtained by Rose and by Sliv and Band and also with the more recent experimental determinations based on the external-internal conversion method ($\alpha_K(\text{ext. int. conv.}) = 302 \pm 4 \times 10^{-4}$). Some experimental values for α_K obtained from the K/β continuum ratio, however, are in disagreement with values for α_K given above and consequently also with the theoretical values. (auth)

14581 CONFIRMATION OF THE PRESENCE OF E0 IN DIRECT COMPETITION WITH M1 AND E2. B.-G. Pettersson, L. Holmberg, and T. R. Gerholm (Univ. of Stockholm). Nucl. Phys., 65: 466-80(Apr. 1965).

Experimental evidence was previously presented for the presence of electric monopole, E0, electron transitions in direct competition with magnetic dipole, M1, and electric quadrupole E2 internal conversion transitions. These experimental results confirmed a theoretical proposition originally advanced by Church and Weneser. However, a re-interpretation of these experiments became necessary because of a recently discovered error in the theory of directional correlations involving conversion electrons. It appears that in the corrected theory the E2 conversion process is of crucial importance. A complete experimental re-investigation was required with special attention to the possible existence of dynamic contributions to the E2 internal conversion process. For this purpose a new experimental technique was applied, with which minute dynamic admixtures to the normal E2 conversion matrix elements could be detected. No evidence was found for the presence of such dynamic factors, and the E2 conversion process may therefore be treated as normal. The accuracy in the knowledge of the M1/E2 mixing ratio of the 333-kev transition in ^{196}Pt was improved by making use of the gamma-electron correlation data presented. The values for the directional correlation coefficients $A_2(\gamma e)$ and $A_2(e\gamma)$ obtained are in agreement with the values reported in the previous papers. Finally the E0 + M1 + E2 mixture was determined. With the new value for the mixing ratio and the experimental results on the E2 conversion process the following results were obtained for the amplitude q of the E0 admixture and for the ratio λ of the M1 penetration matrix element and the corresponding gamma ray matrix element: $q = -0.22 \pm 0.07$, $\lambda = +2 \pm 6$ or alternatively, but less likely $q = +0.39 \pm 0.05$, $\lambda = +68 \pm 12$. It is concluded that, while the correction in the theory has changed both the value and the phase of the E0 amplitude from what was earlier reported, the presence of E0 in direct competition with M1+ E2 remains without doubt. Thus the proposition of Church and Weneser was experimentally verified. (auth)

14582 FERMI MATRIX ELEMENTS IN ALLOWED BETA DECAY. H. Daniel and H. Schmitt (Max-Planck-Institut fur Kernphysik, Heidelberg). Nucl. Phys., 65: 481-9(Apr. 1965).

All measured Fermi matrix elements of normal allowed β decay are compiled. For each case an adopted value is given, which is the mean over all consistent results. The Fermi matrix elements turn out to be small or vanishing, in fair agreement with the isospin selection rule. The question of charge dependence of the nuclear forces is discussed. (auth)

14583 CONVENIENT ANALYSERS OF PROTON POLARIZATION IN THE ENERGY RANGE 1.0-2.4 Mev. I. Bondouk, F. Asfour, V. J. Gontchar, and F. Machali (Atomic Energy Establishment, Cairo). Nucl. Phys., 65: 490-6(Apr. 1965).

The polarization of protons elastically scattered on ^{12}C and ^{9}Be at an angle of 54° center of mass was observed in the energy ranges 1.2 to 2.37 and 1.7 to 2.3 Mev, respectively. The $^{12}C(p,p)$ reaction was used as an analyzer in both cases. The sensitivity of the reaction $^{9}Be(p,p)$ to proton polarization was measured in the energy range from 0.9 to 2.0 Mev using the reaction $^{12}C(p,p)$ as a source of polarized protons. The angular dependence of this sensitivity was measured using polarized protons with an energy of 1.30 Mev and at the five center-of-mass angles (44, 55, 65, 76 and 86°). The asymmetry in the double elastic-scattering of protons on ^{9}Be was also measured to test the data obtained. (auth)

14584 QUASI-PARTICLE INTERACTIONS IN EVEN SPHERICAL NUCLEI. Mannque Rho (Univ. of California, Berkeley). Nucl. Phys., 65: 497-519(Apr. 1965).

The residual terms arising from Bogolyubov-Valatin transformations are studied, and their roles in even spherical nuclei are examined by simple perturbation theory. Simplified equations for the quasi-particle interactions through such terms are examined, and certain conditions are considered to be necessary for agreement with experiments to be obtained. The approximate formulas are applied to some 82-neutron nuclei; the results show qualitative agreement with experiment. (auth)

14585 THE DECAY OF THE 1902 kev 0^+ LEVEL IN Ce^{140}. Per Salling (Universitet, Copenhagen). Nucl. Phys., 65: 520-4(Apr. 1965).

An attempt was made to measure the lifetime of the 1902-kev 0^+ level in ^{140}Ce using a six-gap beta spectrometer and a delayed coincidence setup. The limit $T_{½} < 0.6$ μsec was adopted. (auth)

14586 DETERMINATION BY E_λ TRANSITIONS OF THE EXTENT OF ISOLATION OF α-CLUSTERS IN p SHELL NUCLEI. Yu. A. Kudeyarov, Z. Matthies, V. G. Neudachin, and Yu. F. Smirnov (Moscow State Univ.). Nucl. Phys., 65: 529-44(Apr. 1965).

Earlier investigations are extended by using experimental data on E_λ matrix elements to determine the extent of isolation of α-clusters in ^9Be, ^{12}C, and ^{16}O. To solve this problem, a mathematical formalism for the nucleon cluster model (NCM) is developed, and a sufficiently simple and accurate method is proposed for the interpolation between the shell model and the α-model in terms of a parameter characterizing the extent of α-cluster isolation. (auth)

14587 TRIPLE CORRELATION OF THE $^{12}C(p,p'\gamma)^{12}C$ REACTION. R. C. Bearse, J. C. Legg, G. C. Phillips, A. A. Rollefson, and G. Roy (Rice Univ., Houston, Tex.). Nucl. Phys., 65: 545-58(Apr. 1965). (TID-21255)

A triple correlation was performed on the $^{12}C(p,p'\gamma)^{12}C$ reaction at the $3/2^+$ resonance ($E_p = 5.37$ Mev). Gamma correlations for a set of angles between 0 and 150° were taken for each of a set of proton angles from 40 to 150°. The data were analyzed according to the prescription of Kraus and indicate that the results may be explained assuming a resonant $3/2^-$ state interfering with a small mixture of $1/2^-$ state. (auth)

14588 DENSITY MATRIX METHOD FOR NUCLEAR BINDING ENERGIES. E. G. Weidemann (Universitat, Munich). Nucl. Phys., 65: 559-76(Apr. 1965).

The two-particle density matrix which describes the state of an N nucleon system, may be reduced by integrating over the center-of-mass coordinates of the two particles, due to the translational invariance for the nucleons in the nucleus. Thus arises the problem of N representation for this reduced two-particle density matrix. Bounds on expectation values of the matrix are derived from the N representation for the case of a three-nucleon system. These bounds are used to give an upper bound on the binding energy. As an illustration of the method, three simple examples are considered in which the particles interact by an oscillator potential, a Coulomb-like potential, and by the velocity-dependent Yamaguchi potential. (auth)

14589 GIANT RESONANCES AND FINE STRUCTURE IN Si^{28} FROM THE $Al^{27}(p,\gamma)Si^{28}$ REACTION. P. P. Singh, R. E. Segel, L. Meyer-Schuetzmeister, S. S. Hanna, and R. G. Allas (Argonne National Lab., Ill.). Nucl. Phys., 65: 577-601(Apr. 1965).

The reaction $^{27}Al(p,\gamma)^{28}Si$ was studied over the energy range from 4 to 12.5 Mev. The two prominent gamma rays γ_0 and γ_1 that appear in the capture spectrum correspond to transitions to the ground state and to the first excited state of ^{28}Si at 1.78 Mev. A 90° yield curve taken at 15 kev intervals shows that for each gamma ray the cross section fluctuates widely and rapidly about an average which traces out a giant resonance. The γ_1 giant resonance is displaced upward from the γ_0 giant resonance by an energy about equal to the energy of the first excited state of ^{28}Si. Transitions to the second and/or third excited states of ^{28}Si are also observed, but not resolved from each other. There is evidence that this group ($\gamma_2 + \gamma_3$) also displays a giant resonance at a still higher excitation energy. The fluctuations in the cross sections are analyzed and shown to resemble Ericson fluctuations. There is also evidence for structure of an intermediate width. The angular distributions, measured at 15 kev intervals over representative energy regions, are relatively constant as compared with the fluctuations in the cross sections. The distributions are approximately $W(\theta) = 1 + 0.07P_1$ for γ_0 and $W(\theta) = 1 + 0.10P_1 - 0.50P_2 - 0.10P_3$ for γ_1. Invariant angular distributions suggest fixed configurations for the giant resonances; thus it is not possible to identify the observed structure with individual particle-hole levels. Possible assignments for the giant resonances are discussed. (auth)

14590 THE HALF LIFE AND MASS OF Sc^{41}. D. H. Youngblood, J. P. Aldridge, III, and C. M. Class (Rice Univ., Houston, Tex.). Nucl. Phys., 65: 602-8(Apr. 1965). (TID-21274)

The half life and mass of ^{41}Sc were determined by measurements using resonances of the $^{40}Ca(p,\gamma)^{41}Sc$ reaction. A value of 0.596 ± 0.006 sec was obtained for the half life. The Q value of the reaction was determined to be 1.083 ± 0.006 Mev, corresponding to a ^{41}Sc mass excess of −28,640 ± 10 kev on the ^{12}C mass scale. These results lead to a log ft value of 3.443 for the ^{41}Sc positron decay. (auth)

14591 THE DECAY OF 12.9 d Cs^{136}. R. Reising and B. D. Pate (Washington Univ., St. Louis). Nucl. Phys., 65: 609-34(Apr. 1965).

The radiations accompanying the decay of 12.9-day ^{136}Cs were studied by magnetic electron spectrometry, NaI-scintillation spectrometry, gamma-gamma coincidence spectrometry and sum-coincidence spectrometry. Conversion electrons and gamma rays were observed, arising from gamma transitions of energies 66.7 ± 0.1, 86.2 ± 0.1, 153.0 ± 0.2, 163.7 ± 0.2, 176.2 ± 0.2, 273 ± 5, 340.2 ± 0.2, 818.0 ± 0.5, 1053 ± 10, and 1240 ± 10 kev. Beta groups of end-point energies of 342 ± 5 and 680 ± 80 kev were also observed. The conversion coefficient values and log ft values derived from the measured intensities allow classification of the majority of the transitions observed, and hence deduction of spin and parity changes. A decay scheme is proposed, which is consistent with the present data, previously reported information, and shell-model predictions. The decay scheme includes an isomeric state in ^{136}Ba at an excitation of 2035 kev and spin 7^-, which decays by means of a 164-kev E3 transition. The calculated half life for such a state is 0.28 sec; this evidently corresponds to the 0.3 sec isomer ^{136m}Ba previously observed in the reaction $^{135}Ba(n,\gamma)^{136m}Ba$. Other energy levels in ^{136}Ba are postulated with energies in kev (and spins and parities) of 818(2^+), 1871(4^+), 2058(4^+), 2144(5^-), and 2211(6^+). (auth)

14592 A STUDY OF THE (n,α) REACTION ON O^{16} AT 14 Mev. M. L. Chatterjee (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Physics, 65: 635-40(Apr. 1965).

The $^{16}O(n,\alpha)^{13}C$ reaction leading to about 4 Mev excitation of ^{13}C was studied by bombarding a thin Mylar film and using a nuclear emulsion plate as detector. The angular distribution of the emitted alpha particles is found to be asymmetric about 90° (center of mass) and is peaked in the backward direction, indicating the presence of an exchange effect like heavy-particle stripping. Theoretical fits to the angular distribution were attempted in terms of a heavy-particle stripping process. (auth)

14593 AN ISOSPIN 3/2 LEVEL OF Be^9. B. Lynch, G. M. Griffiths, and T. Lauritsen (California Inst. of Tech., Pasadena). Nucl. Phys., 65: 641-6(Apr. 1965).

A state of ^9Be was found at an excitation energy of 14.392 ± 0.005 Mev, with a width less than 5 kev. The state is formed in the reaction $^7Li(He^3,p)^9Be$ and corresponds closely in energy to the expected analog of the ground state of ^9Li. These facts, together with the small width, suggest an assignment of $T = 3/2$. The angular distribution of protons corresponding to the 14.39-Mev state is nearly symmetric about 90° in the center-of-mass with maxima at 40 and 150°. The 90° differential cross sections are approximately the same for 6.5 and 10 Mev, with a minimum value between these energies. The total cross sections are about 10± mb for 10 Mev and about 7.5± mb for 7.5 Mev. (auth)

14594 GAMMA RAYS FROM A 3/2 ISOSPIN LEVEL IN ^9Be. G. M. Griffiths (California Inst. of Tech., Pasadena). Nucl. Phys., 65: 647-54(Apr. 1965).

The gamma decay of a state in ^9Be at 14.39 Mev was observed via the reaction $^7Li(^3He,p,\gamma)^9Be$. The ratio of the number of ground-state gamma rays from the state to the number of protons forming it combined with 180° inelastic electron scattering measurements of the gamma width,

gives a total width for the state less than 1 kev. This supports the conclusion that the level has $^3/_2$ isospin and indicates an isospin hindrance factor of more than 1000 for break-up of the level by alpha particle or neutron emissions. Gamma rays were also observed from a 14.67-Mev level in ^{9}B which is presumably the mirror to the 14.39-Mev level in ^{9}Be. Some tentative evidence is presented for a further gamma decaying level in ^{9}Be at about 17 Mev, which may correspond to the first excited state in ^{9}Li. (auth)

14595 EXCITATION FUNCTION OF THE REACTION $Al^{27}(p,n)Si^{27}$. I. F. Bubb, J. M. Poate, and R. H. Spear (Univ. of Melbourne). Nucl. Phys., 65: 665-61(Apr. 1965).

An activation technique was used to study the excitation function of the reaction $^{27}Al(p,n)^{27}Si$ for proton energies from threshold at 5.8 to 11.2 Mev with an overall energy resolution of approximately 10 to 15 kev. The absolute cross section is 56 ± 7 mb at 10 Mev. Much structure is evident in the excitation function. An auto-correlation analysis of the data in the proton energy range from 9.5 to 11.2 Mev indicates that if the statistical fluctuation theories may be validly applied in this region the mean level width of the compound nucleus ^{28}Si is 60 kev at an excitation energy of approximately 22 Mev. The half life of ^{27}Si was found to be 4.22 ± 0.05 sec. (auth)

14596 PHOTODISINTEGRATION OF Be^9. A. P. Komar and Eu. D. Makhnovskii (Ioffe Physical-Technical Inst., Leningrad). Nucl. Phys. 65: 662-72(Apr. 1965).

The spectra of photoprotons and alpha particles from the $^9Be(\gamma,p)^8Li$ and $^9Be(\gamma,n)^8Be \rightarrow 2\alpha$ reactions are investigated with the aid of nuclear photoplates in a magnetic field. It is shown that the (γ,p) reaction excitation function plotted by the energy spectrum of protons under the assumption that the recoil nucleus ^{8}Li is produced in the ground state in good agreement with the excitation functions measured by the β^- activity of the residual nucleus ^{8}Li. The data on photoprotons agree with the available calculations of the direct photoemission of nucleons from the nucleus. It is shown that the intensity of (γ,n) processes with the production of ^{8}Be in the second excited state 4^+ roughly equals the overall intensity of the (γ,n) processes with the production of ^{8}Be in states with $E^*_{^8Be}$ from 16.08 to 22.6 Mev. A comparatively high ratio of the yield of deuterons to that of protons ($Y_d/Y_p = 0.20 \pm 0.10$ at $3.7 \leqq E_\gamma, E_d \leqq 14.2$ Mev) is measured. The cross section for the reactions accompanied by deuteron emission is estimated to account for 6 to 7% of the total cross section for the absorption of gamma quanta with energies from 16.7 to 35 Mev. (auth)

14597 PROPERTIES OF THE GAMMA-VIBRATIONAL STATE. D. R. Bes, P. Federman, E. Maqueda, and A. Zuker (Facultad de Ciencias Exactas y Naturales, Buenos Aires). Nucl. Phys., 65: 1-20(May 1965).

The energy and transition probability for the γ-vibrational state are calculated within the framework of the Nilsson single-particle model and the quasiparticle and quasiboson approximations. The Coriolis interaction is taken into account in order to obtain the mixing between the ground state and the γ-vibrational band and to predict values for M1 transition rates and corrections to E2 transitions. The structure of the vibrational wave functions is also discussed. (auth)

14598 NUCLEAR MATRIX ELEMENTS OF THE FIRST FORBIDDEN BETA TRANSITIONS IN THE DECAY OF Ba^{139}, Ce^{141}, La^{140} AND Pr^{142}. P. Lipnik and J. W. Sunier (Centre de Physique Nucleaire, Louvain, Belg.). Nucl. Phys., 65: 21-32(May 1965).

The ratios of the coordinate-type matrix elements involved in the beta decay of ^{139}Ba, ^{141}Ce, ^{140}La, and ^{142}Pr were computed with the help of the jj coupling of the shell model. The theoretical functions for the observable quantities are compared with the available experimental data and exhibit a qualitative agreement. The ratio $\Lambda_\beta = -\int i\gamma_5 \sqrt{\xi} \int \sigma \cdot r$ is computed to be $\Lambda_\beta \approx 1$ for the $^{141}Ce\ ^7/_2^-$ (β) $^{141}Pr\ ^5/_2^+$ transition and $1.3 \leqq \Lambda_\beta \leqq 2$ for the $^{142}Pr\ 2^-$ (β) $^{142}Nd\ 2^+$ transition; these values are obtained from the comparison between the measured polarization of the β and circularly polarized γ correlation and the theoretical function. (auth)

14599 POLARIZATION OF 17.8-Mev PROTONS SCATTERED BY NUCLEI. D. J. Baugh, G. W. Greenlees, J. S. Lilley, and S. Roman (Univ. of Birmingham, Eng.). Nucl. Phys., 65: 33-44(May 1965).

Angular distributions are presented for the polarization of 17.8 Mev protons elastically scattered by ^{12}C, Si, Ca, ^{58}Ni, ^{60}Ni, and Mo and inelastically scattered by ^{12}C and ^{40}Ca. An attempt was made to fit the experimental results in terms of an optical model potential. To obtain information concerning the spin-orbit potential the remaining parameters were chosen consistent with values found for other energies and elements. The spin-orbit potentials required to fit the data were real with the exception of Ca where it was necessary to introduce an imaginary term in order to obtain a good fit. The variation in the depth of the real part of the central potential for the two Ni isotopes is described in terms of a symmetry potential of the form $V_1(N - Z)/A$, with $V_1 = 23 \pm 6$ Mev. The experimental technique involved the single scattering of a totally polarized proton beam obtained by bombarding gaseous hydrogen with 40 Mev alpha particles. (auth)

14600 RELATIVE MEASUREMENTS OF LONGITUDINAL ELECTRON POLARIZATION IN THE BETA-DECAY OF P^{32}, In^{114}, Pr^{142}, Ho^{166}, AND Re^{188}. D. M. Kaminker, G. I. Kharkevich, V. M. Lobashov, V. A. Nazarenko, L. F. Sayenko, and A. L. Egorov (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Phys., 65: 43-53(May 1965).

Relative measurements of the electron longitudinal polarization in the β decay of ^{32}P, ^{114}In, ^{142}Pr, ^{166}Ho, and ^{188}Re were made at $E_\beta \approx 1250$ kev by measuring bremsstrahlung of circular polarization (β particles stopped in a lead target). The circular polarization of the bremsstrahlung γ quanta of ^{114}In, ^{142}Pr, ^{166}Ho, and ^{188}Re β particles was compared with that of ^{32}P β particles. The electron energy was fixed with a magnetic lens spectrometer. (auth)

14601 DETERMINATION OF THE CORRELATION STRUCTURE OF NUCLEI VIA INELASTIC ELECTRON SCATTERING. J. da Providencia and C. M. Shakin (Universitet, Copenhagen). Nucl. Phys., 65: 54-74(May 1965).

It is suggested that the correlation structure of nuclei may be studied through the investigation of inelastic electron scattering form factors at large momentum transfer. A specific example, the excitation of the 3.56 Mev state in ^{6}Li, is considered in the Born approximation. The correlation correction is carried out using a cluster development for the transition operators, and quite large modifications of the shell-model amplitudes due to short-range correlations are found for $q \approx 3\ f^{-1}$. (auth)

14602 RANDOM-PHASE APPROXIMATION FOR SYSTEMS WITH SINGULAR INTERACTIONS. J. da Providencia and C. M. Shakin (Universitet, Copenhagen). Nucl. Phys., 65: 75-80(May 1965).

By using a cluster development of the transformed hamiltonian introduced in an earlier work, the equations of the random-phase approximation are rederived for a nuclear system with singular (hard-core) interactions. The same linearization procedure which leads to the equations of the random-phase approximation yields effective transition operators which are to be used for the calculation of electromagnetic transition rates and for the calculation of form factors for inelastic electron scattering. (auth)

14603 THE EFFECT OF A FINITE-RANGE FORCE ON THE LOCALIZATION OF DIRECT INTERACTIONS. K. A. Amos and I. E. McCarthy (Univ. of California, Davis). Nucl. Phys., 65: 81-9(May 1965).

The question whether direct interactions involving the two-body collision mechanism contain any information about the nuclear interior is discussed in the context of the distorted wave Born approximation with local potentials. While optical-model effects do not completely localize the reaction to the surface, it is shown that the localization is enhanced by the effect of a Yukawa two-body force. In

certain cases, particularly if s-states are involved prominently in the reaction, there is still some difference between angular distributions calculated for different weightings of the interior relative to the surface, even when the interior contribution is weighted by a factor of 50% to reproduce crudely the effects of calculating the wave functions in a nonlocal potential. It is concluded that in most cases nucleon direct interactions are surface phenomena. (auth)

14604 OPTICAL MODEL ANALYSIS OF THE ELASTIC SCATTERING OF DEUTERONS. M. El-Nadi and A. Rabie (Cairo Univ. and Atomic Energy Establishment, Cairo). Nucl. Phys., 65: 90-8(May 1965).

An optical model analysis is carried out for elastic scattering of 15 Mev deuterons on ^{89}Y, ^{93}Nb, ^{98}Mo, ^{107}Ag, and ^{166}Er. Spin-orbit interaction is neglected, and the volume absorption nuclear potential is considered. More than one set of optical parameters were found to give satisfactory fitting with the experimental data. The effect of varying the optical model parameters on the angular distribution of the scattered deuterons is studied and discussed. (auth)

14605 OPTICAL MODEL ANALYSIS OF THE ELASTIC-SCATTERING OF ALPHA PARTICLES. M. El-Nadi and F. Riad (Atomic Energy Establishment, Cairo). Nucl. Phys., 65: 99-108(May 1965).

Elastic scattering data of α particles on silver at 18.7, 22, and 40 Mev are analyzed using the optical model. Satisfactory fits with experiment were obtained for several sets of optical parameters at each energy. The variation of the optical model parameters with energy is given, and the relation with corresponding parameters for the elastic scattering of deuterons on silver is discussed. (auth)

14606 A NEW NUCLIDE EUROPIUM 143. K. Kotajima, K. W. Brockman, Jr., and Gerda Wolzak (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., 65: 109-12(May 1965).

The nuclide europium-143, produced by the (d,3n) reaction on ^{144}Sm, was investigated. The half life of this nuclide was found to be $T_{\frac{1}{2}} = 2.3 \pm 0.2$ min, and the end-point energy of the beta ray was found to be $E_\beta = 4.0 \pm 0.2$ Mev. No strong gamma ray was observed. (auth)

14607 THE ACCURATE DETERMINATION OF SOME (p,n) THRESHOLDS IN THE PROTON ENERGY RANGE 5 TO 10 Mev. J. M. Freeman, J. H. Montague, G. Murray, R. E. White, and W. E. Burcham (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 65: 113-29(May 1965).

The thresholds for the reactions ^{26}Mg(p,n)^{26m}Al, ^{27}Al(p,n)^{27}Si, ^{34}S(p,n)^{34}Cl, ^{54}Fe(p,n)^{54}Co, and ^{58}Ni(p,n)^{58}Cu were measured with an accuracy of ±5 kev or better. The residual nucleus being in each case a positron emitter with a half life in the range 4 to 0.2 sec, it was found convenient to measure the reaction yields by the activation method, positrons being detected between short periods of proton irradiation. The proton energies at the thresholds were measured in terms of the accurately known energies of alpha particles from ThC and ThC′ sources, by comparison in a broad-range magnetic spectrograph. The values obtained for the (p,n) thresholds were 5802.9 ± 3.8 kev in ^{27}Al, 6451.1 ± 4.5 kev in ^{34}S, 9202.7 ± 4.8 kev in ^{54}Fe, 9512.9 ± 5.0 kev in ^{58}Ni. (auth)

14608 PHOTONEUTRON REACTIONS IN THALLIUM UP TO 105 Mev. J. Moffatt and D. Reitmann (Oxford Univ.). Nucl. Phys., 65: 130-44(May 1965).

Experimental investigations of reactions in which one or more photoneutrons are emitted from thallium were made by observing the induced activities. Cross-section curves for all reactions appear to have tails extending to 105 Mev and are shown to be inconsistent with statistical evaporation from an excited nucleus. An approximate value of the total integrated photon absorption cross section was deduced, which exceeds the values predicted by accepted sum rules. (auth)

14609 NEUTRONS FROM THE B^{11}(p,n)C^{11} REACTION. J. C. Overley and R. R. Borchers (Univ. of Wisconsin, Madison). Nucl. Phys., 65: 156-66(May 1965). (COO-7-0334)

Time-of-flight techniques were used to study neutrons from the ^{11}B(p,n)^{11}C reaction for proton energies from 4.0 to 11.5 Mev. Neutron groups were observed from the formation of ^{11}C in its ground state and excited states at measured excitation energies of 2.01, 4.32, 4.81, 6.33, and 6.48 Mev. Excitation functions for these groups were obtained at laboratory angles of 0 and 90°, and angular distributions were taken at 25 proton energies. The excitation functions show structure near proton energies of 4.10, 4.62, 5.07, 5.50, 6.00, 6.4, 7.4, 7.7, 8.2, 8.6, 9.25, 9.7, 10.1, and 10.9 Mev. This structure is superimposed on a more smoothly varying background. (auth)

14610 EXCITATION OF NUCLEI BY A PARTICLE FIELD. V. A. Dyarbashian (Djrbashian) (Inst. of Physics, Erevan, USSR). Nucl. Phys., 65: 167-76(May 1965).

Differential and total cross sections are obtained for the excitation of nuclei by the electromagnetic and nuclear fields of slow particles with arbitrary spin. The predictions of the theory developed are in agreement with the experiments in which nuclear resonance is observed. (auth)

14611 INVESTIGATION OF A 320-MILLISECOND ISOMER AND ITS RELATION TO BARIUM^{135}. Hans Warhanek. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 9, 194-211(1964). (In German)

The 320-msec activity found by Campbell and Fettweis in the irradiation of Ba with fast reactor neutrons was investigated further. The energy of the gamma lines was determined to be 812 ± 10 and 1050 ± 10 kev in agreement with Campbell and Fettweis, but with greater accuracy. By coincidence measurements it was shown that both lines form a cascade. The direct transition from the excited state to the ground state of the cascade was investigated; for its intensity there was an upper limit of 5% of the intensity of the cascade lines. Campbell and Fettweis had established that the reaction leading to the isomer began with ^{135}Ba. All consistent assignments were discussed. It was shown that the isomer with the greater probability was assigned to ^{135}Ba and decayed only over the measured gamma cascade, probably to the known $11/2^-$ ^{135m}Ba. The isomer had a high total angular momentum and an excitation energy with the order of magnitude of the pairing energy. It also represents an additional case of a three-particle isomer. (tr-auth)

14612 PRELIMINARY REPORT ON VARIATION OF THE ACTIVATION CROSS SECTION OF THE REACTION Al^{27}(n,α)Na^{24} RELATIVE TO THE REACTIONS Fe^{56}(n,p)Mn^{56} AND Cu^{65}(n,2n)Cu^{64}. Heinrich Muenzer and Peter Hille. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 9, 212-14(1964). (In German)

The calibration reactions ^{27}Al(n,α)^{24}Na, ^{56}Fe(n,p)^{56}Mn, and ^{65}Cu(n,2n)^{64}Cu were studied in the energy range from 13.4 to 14.2 Mev. Al platelets sandwiched between a Cu and a Fe platelet were irradiated, and the neutron energy was calculated from the sample–target–deuteron beam. The activities produced were followed in their time decay, and no unexpected perturbing activities were found. The results showed that the effective cross sections σ(Al)/σ(Fe) and σ(Al)/σ(Cu) fluctuate in the energy range studied. The maximum variation found was 10%. The origin of the fluctuations was discussed. (J.S.R.)

14613 DETERMINATION OF THE HALF-LIVES OF THE NATURALLY OCCURRING NUCLIDES Sm^{147} AND Lu^{176} USING LIQUID SCINTILLATORS. Dieter Donhoffer. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 10, 186-92(1963). (In German)

The half lives of ^{147}Sm and ^{176}Lu were determined using an extrapolation method on octoate samples of the metals. The extrapolation method and the procedure for the preparation of the octoates are briefly described. The samples were dissolved in liquid scintillators. The half lives of ^{147}Sm and ^{176}Lu were calculated to be $1.04 \pm 0.03 \times 10^{11}$ and $2.18 \pm 0.06 \times 10^{10}$ yr, respectively. (J.S.R.)

14614 (n,2n) EFFECTIVE CROSS SECTION MEASUREMENTS FOR 14.8-Mev NEUTRONS ON Eu^{151}, Er^{170}, Yb^{176},

AND Tl^{205} WITH LIQUID SCINTILLATORS. Hans Spenke. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 10, 197-202(1963). (In German)

Effective cross sections for the (n,2n) reaction at 14.8 Mev on ^{151}Eu, ^{170}Er, ^{176}Yb, and ^{205}Tl were measured using liquid scintillators. The method consisted in the measurement of the specific activity of the nucleus resulting from the reaction, and the measurement of the neutron flux with the calibration reaction $^{27}Al(n,\alpha)^{24}Na$, the cross section of which is accurately known. The cross section is calculated from these two measurements. The measurement techniques are briefly described, and the results are tabulated and compared with previous measurements. The sources of error are discussed. (J.S.R.)

14615 DETERMINATION OF THE EFFECTIVE CROSS SECTION FOR THE (n,He^3) PROCESS ON Mn^{55}, Co^{59}, As^{75}, AND Rh^{103} FOR 14.8-Mev NEUTRONS. E. Frevert. Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz., No. 10, 202-11 (1963). (In German)

The cross sections of the reactions $^{55}Mn(n,^3He)^{53}V$, $^{59}Co(n,^3He)^{57}Mn$, $^{75}As(n,^3He)^{73}Ga$, and $^{103}Rh(n,^3He)^{101}Tc$ were measured for 14.8-Mev neutrons with the activation method. Cross sections of ≤ 0.017 mb ± 50% for Co and ≤ 0.013 mb ± 50% for Rh and upper limits of 0.05 mb for Mn and 0.5 mb for As were obtained. The values measured for Co and Rh deviate sharply from those calculated by the statistical theory of nuclear reactions. The cross section of the reaction $^{55}Mn(n,\alpha)^{52}V$ for 14.8-Mev neutrons was determined to be 13.8 mb ± 15%, and a 30-sec activity was measured, which probably must be assigned to a previously unknown isomer of ^{56}Mn. (tr-auth)

14616 THE ELECTRON CAPTURE DECAY OF ^{195}Au. W. Goedbloed, E. Mastenbroek, A. Kemper, and J. Blok (Vrije Universiteit, Amsterdam). Physica, 30: 2041-50 (Nov. 1964).

Measurements on the electron capture decay of ^{195}Au–^{195}Pt are presented. A gamma radiation of 210 kev was observed that was not reported previously. The transition energy is obtained from KX-gamma and LX-gamma coincidences, $Q_T = 226 \pm 2$ and $Q_T = 229 \pm 1$ respectively. Branching ratios, relative intensities, and conversion coefficients are given. (auth)

14617 ON THE GAMMA RADIATION OF ACTINIUM K. C. Ythier, G. Mazzone, and P. W. F. Louwrier (Instituut voor Kernphysisch Onderzoek, Amsterdam and Institut d'Etudes Scientifiques, Nice). Physica, 30: 2143-6 (Dec. 1964). (In French)

The gamma spectrum of ^{223}Fr was measured, after chemical separation, using a scintillation spectrometer. A very complex spectrum was observed extending up to 781 kev. The energies and relative intensities of eleven gamma rays were determined. The results show that there are no 215- and 310-kev levels in ^{223}Ra. (D.C.W.)

14618 PROTONS FROM THE ALPHA-PARTICLE BOMBARDMENT OF ^{23}Na. J. Kuperus (Rijksuniversiteit, Utrecht). Physica, 30: 2253-60(Dec. 1964).

Resonances in the yield of ground-state protons from alpha-particle bombardment of ^{23}Na were investigated in the energy range from 1.0 to 3.3 Mev. At least thirty-eight resonances were observed. Resonance energies and strengths are presented. At nine resonances angular distribution measurements lead to unique values of the spin of the resonance level. In two of these cases, the parity of the resonance level was also determined. In two other cases, the angular distribution left two possibilities for the resonance spin. Angular distributions at ten other resonances could not be treated with a single-level analysis. (auth)

14619 A SEARCH FOR FAST NEUTRON DETECTORS WITHOUT A THRESHOLD. I. Heertje, L. Delvenne, W. Nagel, and A. H. W. Aten, Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 30: 2290-4(Dec. 1964).

The reactions $^{35}Cl(n,p)^{35}S$ and $^{209}Bi(n,\gamma)^{210}Bi$ were investigated in connection with their possible use for the detection of fast neutrons, in particular neutrons with energies just below 1 Mev. Cross sections vs energy curves are proposed, and the possibility of using these reactions to measure neutron flux densities is discussed. (auth)

14620 INJECTION OF RADIOACTIVE NUCLEI INTO A PHOTOEMULSION. I. B. Berkovich, A. P. Zhdanov, G. G. Martysh, and L. I. Shur. Pribory i Tekhn. Eksperim., No. 6, 63-4(Nov.-Dec. 1964). (In Russian)

A strong ionizing radiation background formed during nuclear synthesis interfered with a direct introduction of synthesized radioactive nuclei on the photoemulsion. A method is suggested for injecting radioactive nuclei on a fine gelatin film insensitive to ionizing radiation. Experiments were carried out to investigate decay products of RaTh. After synthesis the nuclei were injected on the gelatin film which was later glued between two sensitive photo plates. (tr-auth)

14621 DETERMINATION OF SELF-ABSORPTION OF Co^{60} BETA PARTICLES BY PROPORTIONAL 4-PI COUNTER. A. A. Konstantinov and V. V. Perepelkin (All-Union Scientific Research Inst. of Metrology, USSR). Pribory i Tekhn. Eksperim., No. 6, 69-72(Nov.-Dec. 1964). (In Russian)

Self-absorption coefficients for ^{60}Co β particles for sources prepared with $CoCl_2$ on a thin layer were measured by comparing them to β and γ emission from drop sources and from a standard source which does not possess self-absorbing properties. The standard ^{60}Co sources were developed by evaporating metallic radioactive cobalt on metallic foils in a vacuum. (tr-auth)

14622 THE NEUTRON-PROTON INTERACTION IN K^{40} AND Cl^{38}. K. Sasaki. Soryushiron Kenkyu, 26: 285-8 (1962). (In Japanese)

The neutron-proton interaction was investigated by analyzing the energy levels of ^{38}Cl and ^{40}K, for which the neutron-proton configurations in the shell model are unambiguous. (D.C.W.)

14623 THE NEW PROBLEM OF RaE(FOR CVC THEORY). J. Futitu. Soryushiron Kenkyu, 26: 517-21(1963). (In Japanese)

By consideration of the coupling constant-nuclear matrix element relations obtained by using the cancellation theory to analyze the beta spectrum of RaE (^{210}Bi), it is shown that the cancellation theory is not credible. The validity of beta-charge conservation is discussed in terms of a theorem analogous to the Siegert theorem in electromagnetic interaction. (D.C.W.)

14624 AN INTRODUCTION TO LANGER EFFECT. S. Nakamura and T. Konuma. Soryushiron Kenkyu, 26: 539-41(1963). (In Japanese)

Enhancement of the lower-energy components of beta spectra in comparison with the statistical forms was observed by Langer. Results for ^{114}In, ^{90}Y, ^{32}P, ^{22}Na, ^{147}Pm, ^{143}Pr, ^{89}Zr, ^{56}Co, ^{66}Ga, and ^{198}Au are presented, and the theory of the Langer effect is outlined. (D.C.W.)

14625 POSSIBLE SIX-FERMION INTERACTIONS. T. Komura and M. Morita. Soryushiron Kenkyu, 26: 548-50 (1963). (In Japanese)

The spectrum of RaE and the Langer effect are described by using 6-body fermi interaction, and beta decay is formulated in terms of 6-body Fermi interaction. It is concluded that the Langer effect and double beta decay cannot be simultaneously described by 6-body Fermi interaction without further assumptions. (D.C.W.)

14626 ON f^0-MESON IN THE STRONG REACTION. I. THE CONTRIBUTION TO NUCLEAR FORCE. T. Ino and N. Hiroshige. Soryushiron Kenkyu, 28: 225-34(1963). (In Japanese)

The contribution of the 1250-Mev resonance in the final state of the interaction $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ to the nuclear force is studied in terms of the theory of Sawaka. The quantization of the tensor field and its interaction with the spinor field are described, and the nuclear potential and the partial-wave amplitude are calculated. (D.C.W.)

14627 ON THE RELATION BETWEEN THE CRANKING MODEL AND PEIRLS-YOCCOZ OR HILL-WHEELER'S METHOD. Y. Shona. Soryushiron Kenkyu, 28: 3?1-9(1963). (In Japanese)

The relation between the classical cranking model and the quantum methods for describing nuclear rotation is studied. (D.C.W.)

14628 THE COLLECTIVE VIBRATION OF NUCLEI AND PAULI PRINCIPLE. K. Iketa and T. Utagawa. Soryushiron Kenkyu, 28: 402-13(1964). (In Japanese)

It is shown that the boson approximation for fermion-hole pairs is not suitable for treatment of collective vibrations due to the large pair correlation in the ground state. The Pauli principle is introduced in an attempt to decrease the correlation. (D.C.W.)

14629 HYPERFINE FIELDS IN ERBIUM METAL. S. Huefner, P. Kienle, W. Wiedemann, and H. Eicher (Technische Hochschule, Munich). Z. Physik, 182: 499-509 (1965).

The hyperfine splitting of the 80.6-kev γ transition in ^{166}Er was measured in erbium metal between 4.2 and 40°K using the Mössbauer effect. There is evidence for a unique magnetic field and electric field gradient at all nuclei in erbium metal. The magnetic field decreases from $(7.55 \pm 0.20) \times 10^6$ Oe at 4.2°K to $(6.10 \pm 0.40) \times 10^6$ Oe at 40°K. Extrapolation to 0°K yields H (0°K) = $(7.60 \pm 0.20) \times 10^6$ Oe. The quadrupole interaction energy for the 80.6-kev state is $eQV_{z'z'}/4 = (0.95 \pm 0.20) \times 10^{-8}$ ev at 4.2°K. These results are discussed and compared with other measurements. (auth)

14630 ISOTOPIC EFFECT AND PROTON POLARIZATION DURING ELASTIC SCATTERING ON NICKEL NUCLIDES. V. I. Chirko. Zh. Eksperim. i Teor. Fiz., 47: 1581-2(Oct. 1964). (In Russian)

The purpose of the investigation was to obtain data on the polarization of protons scattered by nuclei of ^{58}Ni, ^{60}Ni, ^{62}Ni, and ^{64}Ni and to check whether the proton polarization is related to the isotope effect. The polarization was measured by the double scattering method, in which the first scatterer was a self-supported film of the tested isotope and the second scatterer was a carbon film. A 6.9-Mev proton beam from a cyclotron was used. The protons were detected by a telescope consisting of a scintillation spectrometer and a scintillation counter with a thin crystal. In some measurements the scintillation counters were replaced by proportional counters. The results of the polarization measurements are shown together with the elastic scattering differential cross section. The polarization of protons elastically scattered by ^{58}Ni and ^{60}Ni is in good agreement with the polarization of protons of the same energy scattered by nickel of natural isotopic composition. For ^{62}Ni and ^{64}Ni the proton polarization is noticeably different from ^{58}Ni and ^{60}Ni, especially at large angles. It is concluded that the cause of the difference in polarization of the nickel isotopes may be the difference in spin-orbit interactions with different nuclei. (ATD)

14631 ELASTIC SCATTERING OF 13.6-Mev DEUTERONS ON GOLD AND BISMUTH NUCLEI. A. N. Vereshchagin, L. A. Sokolov, and I. P. Chernov (Tomsk Polytechnic Inst., USSR). Zh. Eksperim. i Teor. Fiz., 47: 1583-4(Oct. 1964). (In Russian)

The investigation was undertaken to provide better data on the elastic scattering cross sections at all angles, and to check on the possibility of describing elastic scattering of deuterons by heavy nuclei by means of the optical model. The measurements were made with the cyclotron of the Scientific Research Institute of Nuclear Physics, Electronics, and Automation at the Tomsk Polytechnic Institute. The deuteron energy was 13.6 Mev. The external deuteron beam was focused and guided to a target located at the center of a 1.5 meter diameter scattering chamber. The beam current was recorded by thin-crystal scintillation counter monitors and the scattered deuterons were detected by a scintillation-counter telescope. The targets were vacuum-evaporated gold and bismuth of thickness 2.1 and 2.7 mg/cm^2, respectively. The measurements were in the angle range 10–165°. A comparison of the experimental data with those by others shows that the differential cross sections in the 20–40° region are pure Rutherford cross sections, and that the optical model of the nuclear interactions calls for further refinement if it is to be used for deuterons. At medium and large scattering angles the cross sections measured in the present work differ from those by others by 20–50%. (ATD)

14632 INVESTIGATION OF THE (p,p′) REACTION AT THE 1.65- AND 1.83-Mev LEVELS IN ^{27}Al. S. S. Vasil'ev and D. L. Chuprunov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1585-7(Oct. 1964). (In Russian)

The reaction ^{27}Al(p,p′) was investigated with excitation of the 1.65 and 1.83 Mev levels. The protons were accelerated in the 120 cm cyclotron. A target of 0.988 mg/cm^2 was prepared from an aluminum foil rolled from a crystal 99.9% pure or better. The protons scattered by the target were recorded by a multichannel scintillation spectrometer. The spectrum of the protons inelastically scattered by the ^{27}Al disclosed intermediate small peaks due to the protons scattered with the excitation of the 1.65 and 1.83 Mev levels. The angular distributions for these groups were measured at several values of the incident proton energy between 6.15 and 6.17 Mev. These angular distributions were found to be sharply asymmetrical about 90° in the cms, and to maintain the same shape for all incident proton energies. All are well described by the square of the spherical Bessel function of zero order. A study of the excitation function and of the excitation cross sections of the investigated levels, together with the experimental data and the analysis, indicate a direct mechanism for the ^{27}Al (p,p′) reaction, with these levels having a quantum number $\frac{1}{2}^+$. The level scheme deduced from these data for ^{27}Al is shown. (ATD)

14633 ON THE PROPERTIES OF A TAIL IN THE CROSS-SECTION OF INELASTIC INCOHERENT SCATTERING OF SLOW NEUTRONS IN CRYSTALS. Yu. Kagan and A. P. Zhernov. Zh. Eksperim. i Teor. Fiz., 47: 1997-9 (Nov. 1964). (In Russian)

It is shown that the tails in the energy dependence of the cross section for the scattering of slow neutrons in crystals, which were particularly strongly manifest in previous investigations in the case of vanadium, are an unavoidable consequence of the anharmonic effects in the crystal. This is done by expressing the differential cross section of inelastic incoherent scattering by an arbitrary crystal in first order in terms of the ratio of the recoil energy per nucleus to the characteristic phonon-spectrum frequency and showing that a finite value of the cross section is observed above the end-point frequency if the anharmonicity constant is finite. Cubic anharmonicity alone is sufficient to extend the tail to double the maximum end-point frequency. It is shown further that in the presence of anharmonicity the cross section for incoherent scattering no longer determines uniquely the thermodynamic properties of the crystals. (ATD)

14634 NEUTRON SCATTERING ON SPIN WAVES IN IRON. G. M. Drabkin, E. I. Zabidarov, Ya. A. Kasman, A. I. Okorokov, and V. A. Trunov (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 2316-18(Dec. 1964). (In Russian)

The results of experiments on the scattering of polarized neutrons by single-crystal iron, aimed at investigating the excitation and absorption of spin waves in small-angle neutron scattering are reported. The experimental set-up is shown. The mirror system made it possible to obtain intense beams of quasimonochromatic neutrons with polarization larger than 80% without beam broadening. The sample was placed in a 26 kG field. The measurements were made at scattering angles in the range 6–20°. The results indicate that the cross section for neutron scattering with spin-wave excitation is not equal to the cross section for scattering with absorption, and that with increasing scattering angle absorption predominates over excitation, in agreement with calculations. Scattering of an unpolarized beam at approximately the same angles resulted in a polarization on the order of 20%. It is concluded that scattering of neu-

trons by spin waves is actually accompanied by spin flip, and that the character of scattering depends on the parameter $2\mu_0 H/E$ (E – energy of incident neutrons). (ATD)

14635 LECTURES ON NUCLEAR MANY-BODY PROBLEM. C. Bloch. Bombay, Tata Inst. of Fundamental Research, 1962. 144p.

Systems of interacting particles are studied with primary consideration of fermion systems and application of the theory to nuclear structure. The many-body problem is first treated by using an independent-particle solution as the zero-order approximation. The independent quasi-particle solution is then used as the zero-order approximation; and the remaining residual interactions are treated by perturbation theory, using the technique of Feynman diagrams. The two special cases of the high- and low-density limits are considered, the Brueckner theory being obtained in the latter case. The statistical mechanics of many-particle systems are also considered. (D.C.W.)

14636 BETA-GAMMA CIRCULAR POLARIZATION CORRELATION STUDIES OF Sc^{46} AND La^{140}. Ramesh Madhao Singru. Thesis, Lafayette, Ind., Purdue, Univ., 1964. 126p.

The $\beta-\gamma$ circular polarization correlation in the decay of Sc^{46} and La^{140} was studied. The measurements were made by employing four β detectors at different angles. In the case of Sc^{46}, the source ($ScCl_3$) was placed in an evacuated chamber and the data were compared with the data of ^{60}Co. The value of the asymmetry parameter A in the $\beta-\gamma$ circular polarization correlation expression, $W(\theta,\tau) = 1 + (v/c)\,\tau\,A\cos\theta$, was found to be $A = 0.19 \pm 0.03$ for the allowed β transition (E_{max} = 0.357 Mev) of ^{46}Sc. Analysis of $\gamma-\gamma$ directional correlation measurements in ^{46}Ti indicate that static interactions cannot be held responsible for the attenuation of the $\beta-\gamma$ circular polarization correlation observed previously. The angular dependence of the degree of circular polarization, $P_c(\theta_{\beta\gamma})$, of the 1.6-Mev γ ray following the nonunique first-forbidden β transition (E_{max} = 2.175 Mev) of ^{140}La was determined. The analysis of this data combined with the shape factor and $\beta-\gamma$ directional correlation measurements was carried out on the basis of the Kotani parameters z, x, u, and Y. Information obtained about the nuclear matrix parameters may be summarized as follows: $z = 1.0$, $x = +(3.0 \pm 1.5)$, $u = +(0.5 \pm 0.3)$, and $Y = +(2.2 \pm 1.0)$. By combining this result with the log ft value of the 2.175-Mev β transition, nuclear β-matrix elements were obtained. All the four nuclear matrix elements are of the same order of magnitude. The observed nonstatistical shape of the 2.175-Mev β transition and the large ft value indicate a deviation from the ξ-approximation which can be now explained by a possible cancellation effect occurring among the β-matrix elements of this transition. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14637 LEVEL STRUCTURE OF Cr^{53}. Aimar André Rollefson. Thesis, Houston, Tex., Rice Univ., 1964. 90p.

Gamma decay schemes for ten excited states of ^{53}Cr, produced in the reaction ^{52}Cr (d,pγ)^{53}Cr, were measured by means of particle-gamma coincidence techniques. Targets of natural chromium and enriched ^{52}Cr were bombarded with 4.0-Mev deuterons. Protons were detected by a solid state surface barrier detector, while gamma rays were detected by a 3 × 3 in. NaI(Tl) crystal. The particle-gamma coincidences were recorded using the recently developed Rice University Bonner Nuclear Laboratory IBM 1401 computer analyzer system as a 1000 × 1000 channel two-dimensional pulse height analyzer. Energy levels were observed in ^{53}Cr at 0.56, 1.01, 1.29, 1.54, 1.97, 2.32, 2.69, 3.19, 3.60, and 3.70 Mev. Additional confirmation of the existence of a level in ^{53}Cr at 1.54 Mev was obtained from a study of the ^{52}Cr (p,p'γ) ^{53}Cr reaction. Combining the results of the gamma decay measurements with additional information on the level structure of ^{53}Cr, particularly stripping analysis, suggests the following tentative spin and parity assignments for ^{53}Cr: 0.56-Mev state, $\frac{1}{2}^-$; 1.01-Mev state, $\frac{5}{2}^-$; 1.29-Mev state, $\frac{7}{2}^-$; 1.54-Mev state, $\frac{7}{2}^-$; 2.32-Mev state, $\frac{3}{2}^-$; 3.60-Mev state, $\frac{3}{2}^-$; and 3.70-Mev state, $\frac{9}{2}^+$. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14638 LOW ENERGY STRUCTURE STUDIES OF ODD DEFORMED NUCLEI. Gordon Lee Struble. Thesis, Tallahassee, Florida State Univ., 1964. 282p.

The theoretical implications of results of (d,p) stripping experiments on ^{159}Tb, ^{165}Ho and ^{175}Lu are discussed. The Florida State University tandem van de Graaff accelerator in conjunction with a Browne-Buechner broad range magnetic spectrograph was used for this work. A nonlinear least squares analysis was essential to fit the data because of the complexity of the raw data due to high level densities. Since large amounts of computer time are involved, it proved feasible only to fit the areas of the spectra which are the most interesting theoretically. The experiments yielded level schemes and relative cross sections. The theoretical analysis consists of predicting the level structure from the known spectra of neighboring isotopic and isotonic odd-A nuclei. Using parameters that depend on the detailed single particle structure of the nucleus, the rotational Hamiltonian is diagonalized in a direct product basis $D^I_{MK}\,x_{Q1}\,x_{Q2}$ after proper symmetrization where x_{Qi} i = 1,2 are the Nilsson wavefunctions. After reasonable energy and intensity fits are obtained using the simple rotational model and distorted wave reaction theory, methods for determining the effects of the particle-particle interactions more quantitatively by central force calculations are discussed. These show if the parameters are reasonable and, if they are, it gives a quantitative description of the effective neutron-proton interaction in the region of the nuclear periodic table. It is expected that when this data is compatible with the (n,γ) experimental data, it will provide a unique and complete description of the low energy properties of ^{160}Tb, ^{166}Ho, and ^{176}Lu. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14639 THE Fe^{54}(d,p)Fe^{55} REACTION AND THE NUCLEAR STRUCTURE OF Ti^{51}, Cr^{53}, AND Fe^{55}. James Robert Maxwell. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 85p.

Energy levels in ^{55}Fe were investigated by means of the ^{54}Fe(d,p)^{55}Fe reaction using 7.8-Mev deuterons from the University of Michigan 42-inch cyclotron. The protons were analyzed with the associated high resolution magnetic analysis system. Twenty-eight levels were found up to an excitation of 5.4 Mev. Angular distributions were obtained for eighteen of these levels at thirteen angles in the range from 10° to 80°. The l_n-values and reduced widths were extracted from the data using a distorted wave analysis. The differential cross sections for the remaining ten levels were less than about 0.1 mb/sterad at all angles observed. An attempt is made to understand the spectra of ^{51}Ti, ^{53}Cr, and ^{55}Fe in terms of a shell model description involving configurations of 2, 4, or 6 ($1f_{\frac{7}{2}}$) protons coupled to a single neutron in the $2p_{\frac{3}{2}}$, $2p_{\frac{1}{2}}$, or $1f_{\frac{5}{2}}$ orbit. The results of the shell model calculation for ^{51}Ti, ^{53}Cr, and ^{55}Fe are in good agreement with experiment for levels lying below an excitation of about 2 Mev. Above 2 Mev the model is inadequate, and perhaps the higher lying levels in these nuclei might be better understood in terms of a shell model description including collective excitations of the ^{48}Ca core. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14640 ISOBARIC ANALOGUE STATES IN HEAVY NUCLEI. Cornelius Frederick Moore. Thesis, Tallahassee, Florida State Univ., 1964, 148p.

Isobaric analogue states observed as compound nucleus resonances are discussed. Resonances of this type were first observed in the neutron excitation curve from ^{89}Y(p,n)^{89}Zr. The neutron excitation function exhibited large resonances with the same energy spacing as the states found in the spectrum of the reaction ^{89}Y(d,p)^{90}Y. From proton elastic scattering experiments the compound nuclear levels were found to have the same spins and parities as the corresponding levels in ^{90}Y. This strong indication of the compound nucleus resonances being isobaric analogue levels was further verified by a similar set of experiments on ^{88}Sr. Since these original experiments analogue states were studied using targets of ^{90}Zr, ^{91}Zr, ^{92}Zr, ^{94}Zr, ^{96}Zr, ^{92}Mo, ^{94}Mo, ^{95}Mo, ^{96}Mo, ^{98}Mo, ^{100}Mo, ^{112}Sn, ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{119}Sn, ^{120}Sn, ^{122}Sn, and ^{124}Sn. The zirconium and

molybdenum experiments are reported in detail and the results from the tin isotopes are only used in the study of Coulomb energy systematics. As a consequence of these experimental findings these resonances make it not only possible to study Coulomb energy systematics more accurately than before but also opens up a new method of doing nuclear spectroscopy. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14641 PARTICLE PARAMETERS OF E2 TRANSITIONS IN Sm^{152} AND Gd^{152}. Ted Mason George. Thesis, Nashville, Vanderbilt Univ., 1964. 93p.

Possible nuclear structure effects in the K-internal conversion process were investigated through studies of the particle parameters of the converted transitions. The gamma-gamma, e_K-gamma, and gamma-e_K correlations of the 245-122 kev, 4+ → 2+ → 0+ cascade transitions in the deformed nucleus $_{62}Sm_{90}^{152}$ were measured. A magnetic lens spectrometer was used in the correlation studies involving the K-conversion electrons. The particle parameter, b_2, of the 122-kev transition was determined to be 1.65 ± 0.27, which is in agreement with the theoretical value of 1.89 within limits of error. It is concluded that there is little, if any, evidence for nuclear structure effects here. The particle parameter for the 245-kev transition was found to be $b_2 = 1.05 \pm 0.24$, which is in definite disagreement with the theoretical value of $b_2 = 1.72$. It is possible that some attenuation occurs in the e_K-gamma angular correlation that does not occur in the gamma-gamma angular correlation. These data may constitute evidence for some nuclear structure effect in the conversion process of the 245-kev transition. The gamma-gamma and gamma-e_K correlations of the 778-344 kev, 3− → 2+ → 0+ cascade transitions in the near spherical nucleus $_{64}Gd_{88}^{152}$ were also measured. The gamma-gamma angular correlation was found to have a lower anistropy than expected. The experimental particle parameter for the 344-kev transition was found to be $b_2 = 1.85 \pm 0.24$, which is just about one standard deviation from the theoretical value. Exact agreement with theory is obtained for b_2 if the theoretical gamma-gamma angular correlation is used. The conversion coefficient for the 344-kev transition agrees approximately with theory. Thus these data give no strong evidence for nuclear structure effects in this E2 transition. (A.G.W.)

14642 INELASTIC NUCLEON SCATTERING AND THE SHELL MODEL. William Edward Gettys. Thesis, Athens, Ohio, Ohio Univ., 1964. 86p.

An extension of the shell model assumptions that provide a description of the low-lying nuclear levels is proposed to include a positive energy nucleon in conjunction with inelastic scattering boundary conditions. This unification of the descriptions of nuclear structure and scattering under the same model assumptions allows an unambiguous interpretation of scattering events in terms of transitions between the stationary states of a closed system. The extended shell model system consists of the bound, extra-core nucleons and a positive energy nucleon, all of which are indistinguishable. The shell model Hamiltonian is symmetric under particle exchange so that both positive and negative energy nucleons move under the influence of an average, central potential and residual two-body interactions. The wave function describing the entire system is completely antisymmetric. Although no numerical results are given, a sample calculation applied to the ground state and first excited state of $_7N^{14}$ is provided to illustrate the features of the theory. (A.G.W.)

14643 NEUTRON POLARIZATION IN THE $C^{12}(d,n)N^{13}$ REACTION. John Post Hallowes, Jr. Thesis, Nashville, Vanderbilt Univ., 1964. 163p.

The polarization P_1 of neutrons from the $^{12}C(d,n)^{13}N$ reaction was measured in the deuteron energy range from 1.1 Mev to 2 Mev at various reaction angles Θ_1. An angular distribution of the neutron polarization was measured for 11 angles between $\Theta_1 = 11.26°$ cms and $\Theta_1 = 140.77°$ cms at a deuteron energy of 1.73 Mev. The maximum value of neutron polarization was $P_1 = -0.409 \pm 0.024$ at $\Theta_1 = 65.18°$ cms in these data. A small amplitude maximum with $P_1 = -0.139 \pm 0.0215$ occurred at $\Theta_1 = 22.3°$ cms followed by a shallow minimum with $P_1 = -0.126 \pm 0.0266$ at $\Theta_1 = 33.7°$ cms. The sign of the polarization throughout the entire angular range was negative in conformity to the stripping reaction rule $P_1 = \pm$ if $J = l \pm \frac{1}{2}$. The neutron polarization was measured at 68.4° lab for 17 deuteron energies between 1.1 Mev and 1.85 Mev inclusively. The sign of the polarization was negative down to 1.16 Mev where it became positive for the remainder of the energy range. A resonant-like structure appeared in these data at deuteron energies which coincided with some of the tabulated (d,n) resonances in this region. A distorted wave Born approximation stripping computation with spin-orbit interactions in the incoming and outgoing channels was obtained at 1.73 Mev deuteron energy with a limited number of numerical values of the optical potentials for the deuteron and neutron elastic scattering. Some features of the polarization angular distribution data were reproduced in these computations together with concomitant good differential cross section fits. The identification of the polarization data of this experiment with a stripping reaction solely, however, is not consistent with the resonant structure indicated in the neutron polarization data measured as a function of the deuteron energy. (A.G.W.)

14644 THE NEUTRON PROTON COUPLING IN Y^{90} AND Tm^{170}. Charles Edward Watson. Thesis, Tallahassee, Florida State Univ., 1964. 92p.

The residual two-particle interaction was investigated experimentally in two extreme cases, the case in which the core nucleus is spherical of ^{90}Y and the case in which the core is deformed of ^{170}Tm. The experiments were carried out using the Florida State Van de Graaff tandem accelerator in conjunction with a Browne-Buechner 60-cm radium magnetic spectrograph. Energy spectra were taken of the outgoing protons from the reaction $^{89}Y(d,p)^{90}Y$ and $^{169}Tm(d,p)^{170}Tm$. Angular distributions were taken with junction counters in the ^{90}Y reaction and with the spectrograph in the ^{170}Tm reaction. The most strongly excited levels found in the ^{90}Y reaction corresponded to the configuration $p_{\frac{1}{2}}\ d_{\frac{5}{2}}$ coupled to spins 2-, 1- at excitation energies of 2.479 and 2.627 Mev, and the configuration $p_{\frac{1}{2}}\ g_{\frac{7}{2}}$ coupled to spins 4-, 3- at excitation energies of 3.002 and 3.164 Mev. The angular distributions taken agreed with the transferred orbital angular momentum assigned from fitting with distorted wave born approximation relative differential cross sections. The lower lying of the doublets formed was found to have the parallel spin orientation if the proton and neutron were in the same Schmidt group and anti-parallel if in the opposite Schmidt group. The low lying levels in ^{170}Tm (less than .4 Mev) were found to correspond to the configuration (411) (521) coupled to give a symmetry axis component of total angular momentum equal to 1 for the lower lying intrinsic state and coupled to zero for the excited state. The K-equal-1 rotational band was found to occur at 0.0, 37.0, 112.5, and 180.8 kev. The K-equal-0 band was found to be split into two separate bands due to the j.j coupling of the proton and neutron of even and odd spin members. Coriolis coupling was found to affect slightly the effective moment of inertia of the two bands. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14645 EXPERIMENTAL POSSIBILITIES OF TESTING THE ASYMMETRIC ROTATOR AND THE VIBRATIONAL NUCLEAR MODELS; DECAY OF Ba^{133}. Lo I Yin. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 127p.

In Part I, various experimental possibilities of testing the asymmetric rotator and the vibrational nuclear models are explored and discussed in detail. The specific test on the asymmetric rotator model proposed by D. P. Grechukhin was considered and performed. This test consists of measuring the quadrupole moment of excited nuclear states by means of its interaction with extranuclear fields. The effect of such an interaction results in an attenuation of the directional correlation function, which involves the excited state of interest as the intermediate state. Directional correlation measurements were performed on the 478-kev−155-kev gamma-ray cascade of ^{188}Os with a powdered source as well as liquid sources of various viscosities. No observable attenuation could be produced.

Estimates of the likelihood of attenuation production involving other excited states of other suitable isotopes showed that in all cases the short lifetimes of the intermediate states render this test infeasible. In Part II gamma-gamma directional correlation measurements in the decay of ^{133}Ba are described. The correlation functions for the 356-kev–82-kev, 302-kev–82-kev, 80-kev–82-kev, and 276-kev–162-kev cascades were found. The results support the spin sequence of $^{7}/_{2}^{+}$, $^{5}/_{2}^{+}$, $^{5}/_{2}^{+}$, $^{3}/_{2}^{+}$, $^{1}/_{2}^{+}$, for the ground state, 82-kev, 162-kev, 384-kev, and 438-kev levels of ^{133}Cs. The multipolarities of the gamma rays are determined to be: 80 kev, (63 ± 9)%E2 + (37 ± 9)%M1; 82 kev, (97.6 ± 0.1)%M1 + (2.4 ± 0.1)%E2; 162 kev, (95.1 ± 0.6)%E2 + (4.9 ± 0.6)%M1; 276 kev, pure E2, 302 kev, (99.7 ± 0.1)%M1 + (0.3 ± 0.1)%E2; and 356 kev, pure E2. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14646 THE DECAY OF Xe^{137}. Ronald Joseph Onega. Thesis, University Park, Pennsylvania State Univ., 1964. 87p.

The decay of ^{137}Xe was studied by scintillation techniques. The radioactive samples were produced by neutron irradiation of natural xenon, which contains 8.87% ^{136}Xe. The half life of ^{137}Xe was found to be 3.95 ± 0.11 minutes. One gamma ray of 0.455 ± 0.003 Mev was attributed to ^{137}Xe. An upper limit of 0.03 of the intensity of this gamma ray is placed on any other gamma ray due to the decay of ^{137}Xe. The end point energy of the beta spectrum was found to be 4.06 ± 0.06 Mev using ^{42}K as a calibration check. A beta ray was found to be in coincidence with the 0.46-Mev gamma ray. A Kurie plot of the beta-gamma coincidence spectrum as well as a subtraction method of the singles Kurie plot were both in agreement with 3.60 ± 0.06 Mev for the lower energy beta group. In order to get the intensity of the two beta transitions, two independent methods were utilized. These indicated a relative intensity of about 0.33 ± 0.03 for the 3.60-Mev beta-ray group and 0.67 ± 0.03 for the 4.06-Mev beta-ray group. Log ft values indicate first forbidden beta ray selection rules for both transitions. This is found to be in accord with shell model predictions. A decay scheme is proposed on the basis of these results. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14647 MAGNETIC-DIPOLE CAPTURE RATE $D(p,\gamma)^3He$. M. Banville and P. D. Kunz. 7p. (CONF-640606-4)

From American Physical Society Summer Meeting, Denver.

Experimental and theoretical values of magnetic-dipole capture cross sections in the reaction $D(p,\gamma)^3He$ are compared for proton energies from 20 to 50 kev. The probability of the mixed symmetry S state in the ground state of ^{3}He is obtained. (M.J.T.)

14648 BRANCHING IN K^{37} POSITRON DECAY. R. W. Kavanagh and D. R. Goosman (California Inst. of Tech., Pasadena). 5p. (CONF-640606-8)

From American Physical Society Summer Meeting, Denver.

Positron decay of ^{37}K and energy levels and gamma spectra of ^{37}Ar were studied, using ^{37}K produced in 12-Mev proton bombardment of natural Ca and in $^{36}Ar(p,\gamma)^{37}K$ reactions at 0.5 to 1.5 Mev. Branching ratios and log ft values are given for the ^{37}K decay. (M.J.T.)

14649 PROPOSED DETECTION OF DYNAMICALLY ORIENTED Co^{57} BY THE MÖSSBAUER EFFECT. Sushil K. Misra and William A. Barker (St. Louis Univ.). 37p. (CONF-640606-7)

From American Physical Society Summer Meeting, Denver.

The Mössbauer effect may be a useful probe of the static and dynamic mechanisms coupling a parent nucleus to a paramagnetic environment in a static and time varying magnetic field. A theoretical expression is developed for the relative intensity ratio $R(v) \equiv [I_\infty - I_t(v)]/[I_\infty - I_t(-v)]$, for a transmission type Mössbauer spectrum of the gamma radiation obtained in the decay of oriented ^{57}Co. This expression explicitly exhibits a sensitive dependence on the occupation numbers of the Zeeman levels of the parent nucleus. The ratio is calculated numerically for the cases of static and dynamic orientation in a field of 100 kg with the source held at 1°K and a warm absorber. Dynamic orientation is assumed to be achieved by the solid effect in which microwave pumping radiation induces transitions which flip the electron spin by one unit and the nuclear spin by two units. The value of R(v) for the dynamic case is $\sim 10^{-2}$ and $\sim 10^{2}$ when v is chosen to provide overlap of the $^{3}/_{2} \rightarrow {}^{1}/_{2}$ and $-{}^{1}/_{2} \rightarrow {}^{1}/_{2}$ emission lines with the $-{}^{1}/_{2} \rightarrow {}^{3}/_{2}$ and $-{}^{1}/_{2} \rightarrow {}^{1}/_{2}$ absorption lines respectively. This differs significantly from R(v) for the static case which is ~1 for the same two overlaps. (auth)

14650 NUCLEAR MAGNETIC SUSCEPTIBILITY IN He^3 VAPOR AND LIQUID. J. E. Opfer, K. Luszczynski, and R. E. Norberg (Washington Univ., St. Louis). 9p. (CONF-651-68)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

In an attempt to increase the accuracy of the normalization of liquid susceptibility data, measurements were made on ^{3}He vapor at 3°K at densities from 5×10^{-4} to 6.6×10^{-2} g/cm^3 and on ^{3}He liquid at 2 and 1°K. No deviation from the Curie law was found, and each set of data was normalized to have a Curie law molar susceptibility. The liquid data are fitted by a curve corresponding to a Fermi gas with a $m^*/m = 11$. The molar susceptibility changes by less than ±1% in going from vapor to liquid at 3°K. The discrepancy between the data and those of Romer is discussed briefly. (D.L.C.)

Plasma Physics and Thermonuclear Processes

Refer also to abstracts 13705 and 13716.

14651 (AD-603668) THE APPLICATION OF LANGMUIR PROBE TECHNIQUES TO FLOWING IONIZED GASES (thesis). Clark L. Brundin (California. Univ., Berkeley. Inst. of Engineering Research). June 15, 1964. Contract Nonr-222(45). 118p. (AS-64-9). $4.00(OTS).

A detailed theoretical and experimental investigation regarding the use of Langmuir probe techniques in a flowing partially ionized gas was carried out. Both free molecule and stagnation point probes were considered. The analysis is restricted to the determination of ion density from the saturated ion current, and the determination of electron temperature from the rate of change of electron current with probe potential. Numerical results are presented for argon, along with the results of a series of experiments conducted in an arc heated supersonic low density wind tunnel. It is concluded that the ion density can be measured accurately with a stagnation point probe, or with a plane free molecule probe surrounded by a guard ring. The electron temperature can be measured accurately with a guarded plane free molecule probe, or with a cylindrical free molecule probe aligned with the flow. Measurements made in flowing gases with other types of Langmuir probes are subject to certain consistent errors. (auth)

14652 (AERE-M-757) LIQUID NITROGEN CONTROL ON ZETA-1A. E. Evans (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1960. 15p. Dep.(mn).

During the running of Zeta, considerable trouble was experienced with the automatic filling system. This led to modifications being carried out during the conversion of Zeta to Zeta 1A in the period May to July 1958. This modified system was very successful in operation. A description is given of the Zeta system, the faults encountered, and the modified Zeta 1A system. (auth)

14653 (AFCRL-64-445) STUDY OF PLASMA AMPLIFIERS. Scientific Report No. 1. J. Coccoli (Microwave Associates, Inc., Burlington, Mass.). Feb. 19, 1964. Contract AF19(628)-452. 108p. (AD-606137). $3.00(OTS).

A combined theoretical and experimental program to

investigate several fast wave interaction mechanisms between microwave radiation and a plasma or electron gas in a uniform magnetic field is described. An average electron model is presented; this model is applicable to the situation of electrons in a rectangular waveguide. The model predicts the predominance of the relativistically dependent mechanism as the phase velocity of the wave approaches infinity, e.g., the situation at waveguide cutoff. Measurements of the absorption of microwave power by electrons in a rectangular waveguide are presented. These data show the relativistic shift of the absorption curve with increasing transverse electron energy. Both from technical and economic considerations, an amplifier device, based on these fast wave mechanisms does not appear to be feasible at this time. To realize a practical amplifier a reliable and economical method of producing a highly anisotropic electron beam must be developed. (auth)

14654 (ARL-64-138) A STUDY OF THE PLASMA BOUNDARY. R. S. Harp (Stanford Univ., Calif. Microwave Lab.). Oct. 1964. Contract AF33(616)-8121. 130p. (AD-609567). $4.00(OTS).

The static and dynamic properties of the plasma sheath are studied. The basic experimental technique was to pass an electron beam through the sheath parallel to the wall. By measuring the deflection of the beam, transverse d-c and r-f electric fields in the sheath are measured. Measurements of the d-c fields are compared with a theory based on a solution of the complete plasma-sheath equation. By means of this comparison it is possible to accurately evaluate the plasma parameters. It is found that in the quiescent sheath, no r-f fields are detected that exceed the sensitivity limit of the measurements, which is 1 v/cm. To observe the variation of externally applied r-f fields through the sheath and plasma, r-f voltage is applied to the plate forming the sheath, and the phase and amplitude of the resulting fields in the plasma are measured with the electron beam by using a null technique. The results are compared with a theory based on an integration of the collisionless Boltzmann equation. The boundary conditions of waves propagating in the plasma are determined by the r-f properties of the sheath, and in some cases sheath losses can form the principal source of attenuation for such waves. The operation of a resonance probe, a device for measuring the density of low density plasmas such as the ionosphere, is readily interpreted in terms of the r-f properties of the sheath. An analysis of the resonance probe is given, and methods are presented for using the resonance probe in practical applications. It is concluded that the static and dynamic properties of the sheath are adequately described by theory, and that the resonance probe can be a useful and accurate device for plasma diagnostic measurements. (auth)

14655 (ARL-64-180) RESEARCH ON RADIATION FROM ARC-HEATED PLASMA. J. C. Morris, G. R. Bach, and J. M. Yos (Avco Corp. Research and Advanced Development Div., Wilmington, Mass.). July 1964. Contract AF33(161)-8390. 86p. OTS.

The spectral distribution of the continuum radiation of nitrogen and argon plasma has been measured for temperatures ranging from 8000 to 13000°K at atmospheric pressure. The wavelength interval, 2680 to 20,900 Å, over which the nitrogen continuum was investigated accounts for approximately 90% of the total energy radiated by the continuum. The spectral distribution of the continuum is integrated to obtain a measurement of the total continuum energy radiated from nitrogen. These data are compared with direct measurements of the total radiation and with a number of theoretical predictions. These comparisons indicate that atomic line radiation is not an important contributor to the total radiation for the conditions under investigation, and that another source of continuum radiation such as the negative nitrogen ion may be an important contributor in the visible region of the spectrum. Electrical and thermal conductivities of nitrogen and argon plasma have also been measured over this temperature range at atmospheric pressure. Comparison is made between theory and other experiments. (auth)

14656 (ARL-64-202) INTERACTION OF RADIATION AND MATTER IN A PLASMA. Ludwig Oster (Yale Univ., New Haven. Observatory). Nov. 1964. Contract AF33-(657)-7271. 46p.

A summary is given of the results obtained in the following areas: the radiation spectrum emitted under the simultaneous action of Coulomb forces and an external magnetic field, the radiation emitted by free particles in the neighborhood of the plasma frequency where the collective behavior of the plasma electrons becomes the dominant factor, the radiative transfer problem in dispersive media which relates the observable spectrum of a plasma source to the internal parameters, such as temperature and density, departures from thermodynamic equilibrium in continuous energy states when the radiative interactions can be separated from collisional transitions, and relativistic corrections that turned out to be negligible under the conditions envisaged. (auth)

14657 (ARL-64-209) AN ANOMALOUS EFFECT OF MAGNETIC FIELD ON STAGNATION-POINT HEAT-TRANSFER IN A SUPERSONIC PLASMA. S. A. Gordon (AeroChem Research Labs., Inc., Princeton, N. J.). Nov. 1964. Contract AF33(657)-10341. 59p. OTS.

Investigation of the effect of a dipole-like magnetic field on heat transfer to a forward stagnation point in a Mach 3 Ar plasma has led to a surprising result. Rather than indicating a change in heat transfer coefficient, the measurements point to a change in the flow field of such a nature that the effective recovery temperature of the gas at the stagnation point is reduced. This effect is much larger than that which continuum theory predicts, and is dependent on conditions upstream of the test section and is also a function of magnetic field direction. (auth)

14658 (ASD-TDR-63-98) SPECTROGRAPHIC ANALYSIS OF PLASMA FLOWS. E. S. Fishburne and S. L. Petrie (Ohio State Univ. Research Foundation, Columbus). Feb. 1963. Contract AF33(657)-7561. 82p. (AD-423323). $2.25(OTS).

Both experimental and theoretical studies are reported relating to the spectrographic determination of the temperature and species concentration distributions across the nozzle exit of an arc heated wind tunnel. A detailed review of the basic theory of spectral line intensities is presented and the various spectrographic techniques for the determination of gas temperatures and species concentrations are given. The performance characteristics of the arc tunnel operating with argon are summarized and the effects of various configuration modifications on the basic performance are described. Spectrographic analyses of the exhaust jet are reported. The results indicate that some degree of non-equilibrium electronic excitation was present at the nozzle exit. The gas temperatures obtained from rotational spectra agree reasonably well with theoretical predictions. (auth)

14659 (CEA-R-2493) QUELQUES RESULTATS DE CALCUL DE COURBES DE DISPERSION AVEC COLLISIONS. (Some Results of Calculation of Dispersion Curves, Including Collisions). Dimitri Lepechinsky and Francois Parlange (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). Oct. 1964. 96p. Dep.(mn).

Dispersion curves including the effect of collisions have been calculated with a 7090 IBM computer for several types of laboratory hydrogen plasmas; $T_e = T_i = 1$ ev; $T_e = 1$ ev, $T_i = 0.1$ ev; $T_e = 10$ ev, $T_i = 2$ ev; and $T_e = 50$ ev, $T_i = 10$ ev, with neutral gas pressures of 10^{-1}, 10^{-3} and 10^{-4} mm Hg and electron densities of 10^{10}, 10^{13}, and 10^{15} cc. The corresponding collision frequencies with neutrals and between electrons and ions have been derived. The dispersion equations used correspond to the macroscopic treatment. The real and imaginary parts of the wave number are presented as a function of real values of the frequency, for electrostatic and electromagnetic waves and for EM waves propagating parallel to a permanent magnetic field of 500 gauss and 12.5 kgauss. (auth)

14660 (CEA-R-2617) DETERMINATION DES GRANDEURS PHYSIQUES D'UNE BOUFFEE DE PLASMA PAR

L'ANALYSE DE SIGNAUX DIAMAGNETIQUES. PREMIERE PARTIE. MODELE D'EXPANSION DE BOUFFEE. DEUXIEME PARTIE. CONFRONTATION DES RESULTATS EXPERIMENTAUX ET DU MODELE D'EXPANSION DE LA BOUFFEE DE PLASMA. (Determination of the Physical Values of a Plasma Puff by Analysis of the Diamagnetic Signals. Part I. Expansion Model for the Puff). Jean Jacquinot, Christian Leloup, and Francois Waelbroeck. (Part II. Comparison of Experimental Results with the Expansion Model for the Plasma Puff). Jean Jacquinot, Christian Leloup, Jean-Pierre Poffe, and Francois Waelbroeck (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Oct. 1964. 80p. (EUR-1916.f). Dep.(mn).

The flow of a dense plasma puff (plasmoid) along the axis of a uniform magnetic field is examined, assuming the following hypotheses: the axial distribution of the line density can be described at any time by a gaussian function whose characteristic parameter is independent of the distance from the axis of the system; and the β ratio is less than 0.6. An approximate solution of the magnetohydrodynamic equations is obtained. The evolution of the characteristic properties of the plasma (local velocity, temperature, and density) can be calculated from a set of equations involving 5 plasma parameters. A method leading to the determination of these parameters is described. It uses 5 characteristics of the diamagnetic signals induced by the plasma in a set of 4 compensated magnetic loops. The model and equations developed are applied to the determination of the plasma parameters, and of their evolution with time, for plasma puffs produced by an electrodeless plasma gun. Agreement is found between the values calculated from the analysis of the diamagnetic signals, and those deduced from the Stark broadening of the Dβ line, from the periods of the radial oscillations of the plasma column, from ballistic pendulum measurements, and from electric probe signals. (auth)

14661 (IPP-1/9) EINE MAGNETFELDSPULE FUR DEN INDUKTIONS-PINCH MIT ZYLINDERSYMMETRISCHEM, ELEKTRISCHEM FELD. (A Magnetic Field Coil for Induction Pinch with Cylindrically Symmetrical Electric Field). W. Koeppendoerfer (Institut fur Plasmaphysik, G.m.b.H., Garching, Germany). Mar. 1963. 11p. Dep. (mn).

The magnetic field coil consists of two coaxial cylinders that are so crossed with spiral grooves that the current is forced into the spiral grooves. The magnetic field and induction of the coil were theoretically determined. It was compared with a conventional Scylla coil. A magnetic field coil was prepared and its magnetic field and induction were measured. Satisfactory agreement was found with theory. The disadvantages of the coil are discussed. (J.S.R.)

14662 (IPP-1/13) UNTERSUCHUNG HYDROMAGNETISCHER INSTABILITÄTEN BEIM LINEAREN Z-PINCH MIT EINER FRAMING-KAMERA. (Investigation of Hydromagnetic Instabilities in a Linear Z-Pinch with a Framing Camera). Eduard Hinterberger (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). July 1963. 56p. Dep.(mn).

The form and growth of the instabilities of the linear Z pinch were investigated experimentally, and the results were compared with theory. The plasma was observed with a framing camera. (J.S.R.)

14663 (IPP/3/22) BETRACHTUNGEN UBER DIE BESCHLEUNIGUNG EINES PLASMAS MIT HILFE DER LORENTZKRAFT. (Observations on Acceleration of a Plasma Using Lorentz Power). G. Hahn and M. Salvat (Institut fur plasmaphysik, G.m.b.H., Garching, Germany). June 1964. 23p. Dep.(mn).

A well-known, simplified, one-dimensional theory, in which heat losses were neglected, was used to calculate the initial conditions for the acceleration of a slightly ionized plasma using Lorentz force. The equations were integrated; the pattern of the magnitudes obtained had only a qualitative value. (J.S.R.)

14664 (JHU-23-P) MAGNETOHYDRODYNAMIC AND PLASMA TURBULENCE. Leslie S. G. Kovasznay (Johns Hopkins Univ., Baltimore). Sept. 1964. Contract Nonr 3623(00). Project SQUID. 22p. (AD-606395; CONF-640804-1). $2.00(OTS).

From 11th International Congress of Applied Mechanics, Munich.

A review of the development in turbulence of electrically conducting media is given for the last 4-5 years. Theories of homogeneous turbulence both passive and active are summarized. The chemical approach in hot wakes is also reviewed. The possibility of electrostatic turbulence is also considered. (auth)

14665 (MATT-310) CESIUM PLASMAS IN A MAGNETIC FIELD WITH VARIABLE CURVATURE. Nicola D'Angelo (Princeton Univ., N. J. Plasma Physics Lab.). Nov. 1964. Contract AT(30-1)-1238. 8p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

Preliminary results obtained with cesium plasma produced by surface ionization of cesium atoms on hot (~2500°K) tungsten and confined radially by a magnetic field with variable curvature are presented. The experiments were performed in the Q-3 device, equipped with special coils to produce the curvature of the magnetic lines. Plasma losses are discussed. (C.E.S.)

14666 (NOLTR-63-165) A NON-UNIFORM-PLASMA, ELECTRICAL-CONDUCTIVITY PROBE. Alan H. Luther (Naval Ordnance Lab., White Oak, Silver Spring, Md.). Aug. 30, 1963. 45p. (AD-422730). $6.60(OTS).

The penetration of a radio-frequency magnetic field into a cylindrically symmetric conducting medium can be used to calculate the conductivity. At a particular point, the ratio of the r-f magnetic field gradient to the r-f magnetic field is a measure of the conductivity at that point. These conductivity calculations are found to be relatively insensitive to errors caused by conductivity gradients. Consequently, this technique can be used to measure conductivity space variations. Experiments with uniform salt solutions and solutions containing conductivity gradients are used to check accuracy. The results of the application of this technique to conductivity measurement of a plasma produced by a one megawatt electric arc-jet are presented. (auth)

14667 (NP-14571) JAHRESBERICHT, 1963 DES INSTITUTS FÜR PLASMA-PHYSIK GmbH MÜNCHEN-GARCHING UND DER EXPERIMENTELLEN ABTEILUNG (PLASMAPHYSIK) DES MAX-PLANCK-INSTITUTS FÜR PHYSIK UND ASTROPHYSIK, MÜNCHEN. (Annual Report, 1963 of the Institute for Plasma Physics GmbH, Munich/Garching and the Experimental Division (Plasma Physics) of the Max Planck Institute for Physics and Astrophysics, Munich). (Institut für Plasmaphysik, G.m.b.H., Garching, Germany and Max-Planck-Institut für Physik und Astrophysik, Munich). 273p. Dep.(mn).

The work done in 1963 in experimental plasma physics, engineering, and theory by the Institute for Plasma Physics and the Plasma Physics Division of the Max Planck Institute on Physics and Astrophysics is summarized. The internal reports and publications of each division on the studies completed are tabulated. (J.S.R.)

14668 (NP-14572) JAHRESBERICHT, 1962 DES INSTITUTS FÜR PLASMA-PHYSIK GmbH MÜNCHEN/GARCHING. (Annual Report, 1962 of the Institute for Plasma Physics GmbH, Munich/Garching). (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). 179p. Dep.(mn).

The work done in experimental plasma physics, engineering, and theory by the Institute for Plasma Physics is summarized. The internal reports and publications of each division on the studies completed are tabulated. (J.S.R.)

14669 (NP-14787) SHOCK WAVES. Scientific Report No. 13. F. Cap and F. Herrnegger (Innsbruck. Universität. Institut für Theoretische Physik). Sept. 9, 1964. Contract 61(052)-675. 15p.

The basic equations for stationary magnetohydrodynamic

shock waves are given as well as the laws of conservation following from them and the shock equations. The evolutionary conditions for fast and slow shock waves are discussed by the shock polar diagram. (auth)

14670 (SC-RR-64-1701) OPERATION CHARACTERISTICS OF THE SANDIA 120-kw PLASMA ARC TUNNEL. P. T. Lubeck (Sandia Corp., Albuquerque, N. Mex.). Nov. 1964. Contract [AT(29-1)-789]. 41p. Dep.(mn); $2.00(cy), 2(mn) OTS.

Experimental results from three of the most common modes of operation of the 120-kw plasma arc tunnel are presented. The modes of operation are argon gas with a straight anode, argon gas with a stepped anode, and nitrogen gas with a stepped anode. The experimental results presented are specific energy of the jet, exit pitot pressure in the jet, relative efficiency of the tunnel, and input power to the tunnel. (auth)

14671 (SIT-134) WAVES AND INSTABILITIES IN BOUNDED PLASMAS. George Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). Summer 1964. Contract AT(30-1)-2813. 79p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The effects of finite size upon the oscillations, instabilities, and radiation characteristics of plasma are studied. (T.F.H.)

14672 (SU-ML-1261) STRUCTURE OF THE DOUBLE-SHEATH IN A HOT-CATHODE PLASMA. F. W. Crawford and A. B. Cannara (Stanford Univ., Calif. Microwave Lab.). Nov. 1964. Contract AT(04-3)-326. 46p. (CONF-641210-1). Dep.(mn); $2.00(cy), 2(mn) OTS.

From American Physical Society Meeting, Berkeley, Calif.

The double-sheath which is normally present in front of a hot-cathode in a low-pressure d-c discharge is considered. A theory of an idealized form of this sheath under space-charge-limited cathode emission conditions is presented. The discrepancies from this model to be expected in a practical situation are discussed, and comparisons are made with experimental results. To obtain these, an electron beam probing technique was used, and electric field measurements were made directly in the cathode sheath of a low-pressure mercury vapor discharge. Good agreement was obtained between the simplified theory and the experiments. (auth)

14673 (USCEC-103-101) RESEARCH IN PLASMA AND MAGNETOHYDRODYNAMICS. Final Report. Zohrab A. Kaprielian (University of Southern California, Los Angeles). Dec. 1963. 25p. (EE-35; AD-601766). $2.00(OTS).

This report summarizes research performed under the grant Plasmas and Magnetohydrodynamics AF-AFOSR Grant 188-63, sponsored by the Air Force Office of Scientific Research. Theoretical and experimental work in the two major areas of plasma diagnostics, and measurements of thermal radiation from a highly ionized current carrying plasma are reported. The results of these investigations were discussed in publications and technical reports and are reviewed briefly. (auth)

14674 (AEC-tr-6533) THERMONUCLEAR WEAPONS. M. B. Neiman and K. M. Sadilenko. Translation of "Termoyadernoe Oruzhie," (a publication of the Military Publishers of the Ministry of Defense, USSR, Moscow, 1958). 21p. Dep.(mn); $1.00(cy), 1(mn) OTS; $2.60(fs), $0.83(mf) JCL.

An outline is given of the principles on which the hydrogen bomb is built. Possible thermonuclear reactions, nuclear fuel composition of the hydrogen bomb, contemporary nuclear weapons, and production of materials for thermonuclear weapons are discussed. (C.E.S.)

14675 (AI-Trans-71) THE SPACE-CHARGE ZONE AT THE ARC PLASMA BOUNDARY. G. Ecker. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from Z. Physik, 135: 105-18(1953). 18p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

In determining the cathode loss the application of the familiar Langmuir laws to the space-charge zone leads to wrong results in the order of size. A calculation of the space charge conditions was evolved taking the electrons, which increase from the plasma boundary toward the field, into consideration. It is found that in the case of the familiar example of the Hq maximum pressure arc this effect reduces the voltage requirement to about one-third of the Langmuir value. The calculated values show that a participation of the thermal field emission in the current transport is indeed not very likely, but that it can however not be excluded at high current densities under certain favorable assumptions regarding the nature of the surface. (C.E.S.)

14676 (UCRL-Trans-1163(L)) TRANSMISSION OF PLASMA ACROSS MAGNETIC BARRIER IN THE PRESENCE OF HIGH-FREQUENCY FIELDS. I. I. Bakaev, Yu. G. Zadesskii, N. I. Nazarov, V. T. Tolok, and A. M. Ukrainskii (Akademiya Nauk Ukr. S.S.R. Fiziko-Tekhnicheskii Institut, Karkov). Translated by Sergey Shewchuk (Univ. of California Lawrence Radiation Lab., Livermore). 1963. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mf) JCL.

The effects of a h-f field on the trapping of a plasma bunch by a magnetic mirror field with stoppers are studied, using a diamagnetic probe. (T.F.H.)

14677 NEGATIVE-ENERGY PLASMA WAVES AND INSTABILITIES AT CYCLOTRON HARMONICS. Abraham Bers (Massachusetts Inst. of Tech., Cambridge) and Sheldon Gruber. Appl. Phys. Letters, 6: 27-8(Jan. 15, 1965).

A set of negative (small-signal) energy waves at cyclotron harmonics are reported, which exist for small densities. The dispersion characteristics are given for stable electrostatic plasma waves with an unperturbed particle distribution of the form $f_0(v) = \delta(v_\perp - v_{0\perp})\,\delta(v_{||} - v_{0||})/2\pi v_{0\perp}$, where $\perp$ and $||$ denote perpendicular and parallel to B_0, respectively. The negative energy waves are determined and are shown to lead to instabilities in a dispersive medium. (D.C.W.)

14678 PROPAGATION OF LONGITUDINAL PLASMA OSCILLATIONS NEAR CYCLOTRON HARMONICS. R. S. Harp (Institut fur Plasmaphysik, Garching, Ger.). Appl. Phys. Letters, 6: 51-3(Feb. 1, 1965).

The propagation of r-f signals between two probes immersed in a plasma was investigated as a function of the probe spacing and the longitudinal magnetic field imposed on the plasma. The transmitted signal-magnetic field curves show an interference pattern in the vicinity of the second and third harmonics of the electron cyclotron frequency. (D.C.W.)

14679 BINARY CORRELATION FUNCTION FOR A HOMOGENEOUS PLASMA IN A UNIFORM MAGNETIC FIELD. M. J. Haggerty (Univ. of British Columbia, Vancouver). Can. J. Phys., 43: 122-30(Jan. 1965).

Previous work on the application of the theory of Prigogine and Balescu to a homogeneous single-species plasma in a static uniform magnetic field was extended. An equation for the binary correlation function was obtained in terms of the one-particle velocity distribution, which is in turn determined by the kinetic equation previously derived. Equations for the binary spatial correlation function and the binary correlation function for the guiding centers were also obtained. It is demonstrated that the binary spatial correlation function represents the well-known Debye-screened equilibrium correlations when the one-particle velocity distribution is the equilibrium distribution. (auth)

14680 QUANTUM STUDY OF THE SCATTERING OF A CHARGED PARTICLE BY A PLASMA. Andrea Levi (Instituto di Fisica, Genoa). Compt. Rend., 259: 3975-8 (Nov. 30, 1964). (In French)

An extension of the theory of Van Hove is considered to take multiple scattering into account. The distribution of the energy lost by a particle crossing a plasma layer of average thickness is calculated. (tr-auth)

14681 ON THE INTERACTION BETWEEN INTENSE HIGH-FREQUENCY RADIATION AND A PLASMA. L. M. Kovrizhnykh and V. N. Tsyovich (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 158: 1306-9(Oct. 21, 1964). (In Russian)

The nonlinear interaction between the radiation and the plasma is analyzed for three cases: absorption or emission of one wave, corresponding to a Cherenkov resonance, two-wave interaction, which corresponds to scattering and is realized in the presence of epithermal beams of charged particles, and three-wave interaction, when coherent interaction described by decay conditions is possible. The analogy between propagation of the high-intensity radiation and the propagation of beams in the plasma is pointed out. Possible acceleration of the particle beams by extraneous radiation are also discussed and possible buildup of instability as a result of the interaction is estimated. (ATD)

14682 PAIR COLLISIONS OF METASTABLE HELIUM ATOMS IN A PLASMA. P. L. Pakhomov and I. Ya. Fugol. Dokl. Akad. Nauk SSSR, 159: 57-9(Nov. 1, 1964). (In Russian)

Pair collision of metastable 2^3S helium atoms is one of three factors governing the afterglow of a helium plasma following termination of the discharge, but has been least investigated, in spite of its being the dominant factor in the 5–15 mm Hg pressure range. The time dependence of the metastable atom concentration after termination of a high-frequency discharge pulse at 77°K, at pressures from 6 to 74 mm. The metastable atom concentration was measured by means of the absorption of the 3889 Å line in a discharge tube 20 mm in diameter and 150 mm long. The reciprocal of the concentration plotted against the time is a straight line, with a slope that increases with the pressure. Comparison with experiments made by A. V. Phelps and S. C. Browne (Phys. Rev., 86: 102(1952)) at 300°K shows that the rate of the process decreases to one-half on going from 300 to 77°K, probably because of the decrease in the average particle velocity. (ATD)

14683 MINIMUM LOSS IN CONDUCTING GAS ACCELERATION IN STRONG ELECTROMAGNETIC FIELDS. G. M. Bam-Zelikovich. Izv. Akad. Nauk SSSR, Mekhan. i Mashinostr., No. 5, 12-19(Sept.-Oct. 1964). (In Russian)

Variational problems on the conducting gas (plasma) acceleration in strong electromagnetic fields (with pressure gradients that are negligible in comparison to electromagnetic forces) were analyzed for the case in which the external magnetic field was much larger than the internal field. Problems on gas acceleration with minimum conducting gas losses in the proper magnetic field were also investigated. (tr-auth)

14684 ELECTRON DENSITY MEASUREMENTS IN THE MAGNETICALLY CONFINED ARC. C. K. McLane, S. Takeda, W. E. Thomas, Jr., and R. C. Thompson (National Bureau of Standards, Washington, D. C.). J. Appl. Phys., 36: 337-41(Feb. 1965).

Three methods were used to obtain electron density as a function of radius in a magnetically confined, low-pressure argon arc. The first utilized the phase shift of a reflected 35-kMc microwave, and the second determined density from the ion saturation current to a Langmuir probe. The third determination utilized the broadening of the H β line emitted by a small quantity of added hydrogen. Agreement among the three methods is satisfactory; the electron density at the axis of this discharge is of order 10^{14} cm^{-3}, in agreement with results obtained by others for discharges of similar type. (auth)

14685 OBSERVATIONS ON CORRELATED FLUCTUATIONS IN TOROIDAL PINCHED DISCHARGES. N. L. Allen, D. Balfour, and R. V. Williams (Associated Electrical Industries, Ltd., Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. C, 7: 1-14(Jan.-Feb. 1965).

An account is given of measurements on fluctuations occurring in the Sceptre III and Sceptre IV discharges, as recorded by time-resolved spectroscopic techniques and by magnetic and Langmuir probes. Systematic properties of repeatability and movement parallel or anti-parallel to the direction of current flow were identified in some cases and measurements of these properties are presented. It is shown that the motions of fluctuations in magnetic field and in spectral line emission are in opposite directions to each other in different regions of the discharge; these results are discussed in the light of recent theoretical work. (auth)

14686 THE WAVE VELOCITIES CAUSED BY FINITE LARMOR RADIUS EFFECTS FOR MHD INSTABILITIES IN A PINCH DISCHARGE. A. A. Ware (Associated Electrical Industries, Ltd., Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. C, 7: 15-28(Jan.-Feb. 1965). (CLM-P35)

Consideration is given to the types of MHD instability expected in the diffuse toroidal pinch discharges observed in the Sceptre experiments. In the central region where there is little or no magnetic shear but an appreciable negative pressure gradient, the instability will be either a pure interchange mode, or a quasi-interchange mode with properties very similar to the pure interchange. In the outer region where there is some magnetic shear, a kink instability is expected. The wave velocity which will be imparted to the interchange mode due to the finite Larmor radius effects is computed with all the first-order effects included. In the few cases where sufficient experimental data are available, there is agreement in sign and magnitude with the observed velocities for fluctuations in the discharge core. There is insufficient experimental data for the outer region, but the wave velocity imparted to the kink instability due to the Hall effect only is shown to be sensitive to the orientation of k with respect to B. This explains why the observed wave velocity is often of opposite sign in the outer region. (auth)

14687 INSTABILITY BOUNDS IN THE COMPRESSIBILITY OF A RESISTIVE PLASMA OF SUPERFICIAL CURRENTS. H. Tasso and M. Cotsaftis (Euratom-CEA, Fontenay-aux-Roses, France). J. Nucl. Energy, Pt. C, 7: 29-36(Jan.-Feb. 1965). (In French)

In the simple case of a cylindrical plasma with superficial current shear, a new instability due to a coupling between compressibility, and resistivity was found. Near acoustic velocity phase, the growth rate of this instability is η . In toroidal systems, this instability can appear under the Kruskal limit, even for the mode m = 1, for which the stability limit is $1/2$ in $1/2\pi$ units, and the stability limit for m >1 modes is the closer to 0 the greater is m. (auth)

14688 LEGENDRE TRANSFORMATION AND CHARACTERISTICS OF THE MAGNETOGASDYNAMIC POTENTIAL EQUATION. F. Cap (Innsbruck Univ., Austria). J. Nucl. Energy, Pt. C, 7: 69-77(Jan.-Feb. 1965).

For the potential equation of the two-dimensional stationary potential flow of a plasma of infinite conductivity, a method of characteristics was derived which is set up in analogy to the Prandtl-Busemann method of gas dynamics. (auth)

14689 THE SCATTERING OF MICROWAVES FROM INHOMOGENEITIES IN A LABORATORY PLASMA. D. J. H. Wort and M. A. Heald (Culham Lab., Abingdon, Berks, Eng.). J. Nucl. Energy, Pt. C, 7: 79-81(Jan.-Feb. 1965).

It is known from electric field, energy balance, and spectroscopic evidence that, in low initial gas pressure conditions, the plasma in Zeta is not internally quiescent but exhibits a random velocity structure over correlation distances of 5 to 10 cm with velocities up to ~10^6 cm/sec. Studies were made to interpret the behavior of the plasma towards microwaves both by directing probing beams into the plasma and by observing the microwave emission with the aim of establishing the scale of the inhomogeneities and following their evolution during the current pulse. Direct evidence is reported for the existence of moving density fluctuations, which were obtained from the transmission and scattering of 2mm microwaves. (C.E.S.)

14690 HELIUM CONTINUUM AFTERGLOW IN THE VACUUM ULTRAVIOLET. R. E. Huffman, J. C. Larrabee, Y. Tanaka, and D. Chambers (Air Force Cambridge Research Labs., Bedford, Mass.). J. Opt. Soc. Am., 55: 101-2(Jan. 1965).

A helium continuum was produced with a mild condensed discharge. The spark-gap trigger was replaced with a thyratron excitation unit so that more precise control of the pulse-repetition frequency could be maintained. Simultaneous oscilloscope traces of the light pulse, and the current pulse through the discharge tube are shown. The principal light pulse was found to begin approximately 0.14 ± 0.02 μsec following termination of the principal current pulse. It reached maximum intensity at 1.4 ±

0.2 μsec following termination of the principal current pulse through the discharge tube, and then decayed slowly. The total effective duration of the light pulse was approximately 16 ± 2 μsec. The same general type of afterglow was observed over a wide range of discharge-tube applied voltages. The observation that the helium continuum is emitted as an afterglow supported the previous explanation of the continuum based on transitions of excited He_2 molecules formed in the discharge. (M.C.G.)

14691 MOVING STRIATIONS IN TAPERED DISCHARGE TUBES. Takashi Kenjo and Yoshisuke Hatta (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 19: 2313-23(Dec. 1964).

It is reported that the wavelength of moving striations is experimentally proportional to R^n, where R is the tube radius and index n ranges from 1.5 to 2.0. Those measurements are done using tapered discharge tubes. A theory that can give a general explanation of the moving striations is introduced. The relation between the wavelength and the tube radius obtained from those theoretical considerations is in a good agreement with the experimental results. (auth)

14692 MICROWAVE MEASUREMENTS OF SHOCKED PLASMA. Chiyoe Yamanaka and Sadao Nakai (Osaka Univ.). J. Phys. Soc. Japan, 19: 2350-1(Dec. 1964).

The complex microwave reflection coefficient on a plane boundary of plasma is discussed. An automatic measuring apparatus for determining the microwave reflection on a shock front, which directly indicates the reflection coefficient in vector form on an X-Y synchroscope, was constructed. The shock wave is generated in argon by a T-type discharge tube and travels down along the expansion tube which also serves as the waveguide of X band microwaves. (C.E.S.)

14693 ON THE RADIAL MIRROR FIELD WITH A MINIMUM B CONFIGURATION. Shigeo Nagao (Nagoya Univ., Japan). J. Phys. Soc. Japan, 19: 2354(Dec. 1964).

It was previously shown that the superposition of a multipolar field upon a mirror field seems to be effective to create a stable configuration for the confinement of a plasma. Such a field configuration is called a minimum B field where the magnetic energy density becomes a non null minimum. A configuration with an axial symmetry of a radial type is examined analytically, and the superposition of an azimuthal field upon that field is suggested to be useful for a high temperature plasma device of a torus type. (C.E.S.)

14694 ON THE IMPEDANCE METHOD FOR MEASURING HIGH ELECTRON DENSITY AND ELECTRON COLLISION FREQUENCY IN A GASEOUS PLASMA COLUMN. Denis M. Coffey (Air Force Cambridge Research Labs., Bedford, Mass.). Japan. J. Appl. Phys., 3: 734-5 (Nov. 1964).

The Lorentz depolarization factor, L, which takes into consideration the contribution of surface polarization to the local electric fields of the plasma electrons, is discussed. In order to investigate the effect of an L-factor on the impedance method for measuring electron density and collision frequency in a gaseous plasma column, simultaneous measurements by the impedance method and by a microwave cavity were conducted on a pulsed xenon discharge. (C.E.S.)

14695 EFFECT OF A MAGNETIC FIELD UPON THE SATURATION ELECTRON CURRENT OF AN ELECTROSTATIC PROBE. Toshihiko Dote, Hiroshi Amemiya, and Torao Ichimiya (Inst. of Physical and Chemical Research, Tokyo). Japan. J. Appl. Phys., 3: 789-96(Dec. 1964).

Some experiments are performed in several kinds of discharged plasma to investigate the influence of a magnetic field upon the saturation electron current of an electrostatic probe. The apparent electron density N_e' and the positive ion density N_+ are calculated from the saturation electron current and the positive ion saturation current respectively and the ratio N_e'/N_+ is plotted against $\omega\tau$ (ω: the angular cyclotron frequency of electrons, τ: the mean collision time between electrons and molecules). The curve is found to show a clear dependence on the gas pressure, and when the ratio is log-log plotted against the magnetic field, it gives a nearly straight line, showing N_e'/N_+ to be 0.1 at about 1,000 gauss. Since the positive ion saturation current is hardly influenced by the magnetic field of the order of several kilogauss, it is apparent that these properties are based upon the behavior of the electrons around the probe. A theory developed by Bohm and others is applied here to explain the experimental results. (auth)

14696 SCATTERING OF ELECTROSTATIC WAVES BY INHOMOGENEITIES IN A PLASMA. P. A. Sturrock (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 8: 281-5(Feb. 1965)

A plane wave excited in an infinite uniform plasma preserves its identity, but a similar wave set up in an inhomogeneous plasma will change in time. If the inhomogeneities are weak, the excitation can be analyzed at any instant into plane waves, the normal modes of the homogenized plasma. The effect of inhomogeneities is to distribute the energy of a single initial plane wave among a spectrum of waves. By studying the time-development of this process, an equivalent damping coefficient can be assigned. The possibility that inhomogeneities may, in this way, suppress an instability, such as two-stream instability, is discussed. (auth)

14697 SINGULARITIES OF THE GREEN'S FUNCTION FOR A COLLISIONLESS MAGNETOPLASMA. J. Nuttall (RCA Victor Research Labs., Montreal). Phys. Fluids, 8: 286-96(Feb. 1965)

A method is given for determining the singularities of the Green's function $G_{ij}(\mathbf{r},\omega)$ for a uniform Maxwellian plasma immersed in a magnetic field and described by the linearized Vlasov equation. The positions of the singularities determine the asymptotic time dependence of the electric field. Only the singularities near the plasma frequency ω_p and the Pythagoras frequency $\omega_\Delta \equiv (\omega_0^2 + \omega_p^2)^{1/2}$ are studied in detail. (auth)

14698 RADIATION PROCESSES IN PLASMAS. T. Birmingham, J. Dawson, and C. Oberman (Princeton Univ., N. J.). Phys. Fluids, 8: 297-307(Feb. 1965).

The problem of arbitrary test current sources embedded in an infinite spatially homogeneous Vlasov plasma is considered. By computing the rate at which the test sources do work on the plasma, the energy emission into transverse and longitudinal waves is obtained. A variety of radiation problems can be handled by appropriate choice of the current sources. Use of the time-varying dipole moment due to encounters between shielded electrons and ions leads to expressions for the bremsstrahlung spectra. If the currents are produced by the interaction of waves with density fluctuations, the scattering and coupling of waves is obtained. By equating the rate of emission of longitudinal or transverse waves to their rate of absorption, expressions for the steady-state energy densities of such waves are obtained. (auth)

14699 ADIABATIC TIME DEVELOPMENT OF PLASMA SHEATHS. Richard L. Morse (Univ. of California, San Diego, La Jolla). Phys. Fluids, 8: 308-14(Feb. 1965).

The formation of the electromagnetic sheath separating a field-free Maxwellian plasma from a confining field is treated by an adiabatic approximation. It is found that the condition imposed by the approximation is not severe. Solutions are shown for several values of the ion-electron temperature ratio. The problem is done in plane symmetry and with the collisionless approximation. The question of stability is not considered. (auth)

14700 GRAVITATIONAL RESISTIVE INSTABILITY OF AN INCOMPRESSIBLE PLASMA IN A SHEARED MAGNETIC FIELD. K. V. Roberts and J. B. Taylor (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). Phys. Fluids, 8: 315-22(Feb. 1965).

The gravitational resistive instability analyzed by Furth, Killeen, and Rosenbluth and subsequent authors is examined from a new point of view, which brings out the connection with ordinary Rayleigh-Taylor instability and thermal convection. In contrast to the modes found previously, which are either sharply localized in the vertical direction or require a boundary layer, it is shown that coherent motions

of arbitrary vertical extent can occur. These alternative modes are derived by first considering a simpler but related model in which resistivity is concentrated at the ends of a system of finite length. This analysis shows that such systems may be unstable even if they satisfy the Newcomb criterion. The new resistive modes do not have the usual periodic dependence along the horizontal direction of the main field, but have finite length and represent convective rolls which are twisted to conform to the field lines. The relation of these new modes to the original periodic localized modes is examined. (auth)

14701 MAXIMUM PLASMA PRESSURE FOR STABILITY IN MAGNETIC FIELDS WITH FINITE MINIMA. J. B. Taylor and R. J. Hastie (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). Phys. Fluids, 8: 323-32(Feb. 1965).

The maximum plasma pressure is discussed for stable containment in magnetic fields that possess a nonzero minimum in field strength, (minimum-B fields or magnetic wells). The basic limitations are on the pressure gradient and are calculated exactly for a special class of equilibria and more generally by an expansion procedure based on a shallow-well approximation. Transcribed into estimates of the critical pressure itself, these results indicate a maximum pressure equal to the depth of the magnetic well. If B_1 is the field strength at the largest closed $|B|$ contour and B_2 is the field strength at the lowest point of the well, then $p_\perp^{max} \simeq \frac{1}{2}(B_1^2 - B_2^2)$. (auth)

14702 FINITE AMPLITUDE INSTABILITY OF A PLASMA COLUMN. Oeivin Holter and Roy R. Johnson (Universitet, Bergen). Phys. Fluids, 8: 333-44(Feb. 1965)

A weakly ionized cylindrical plasma column is investigated in a longitudinal magnetic field larger than the critical field which makes the column unstable to small perturbations. The restriction of small perturbations is removed by superimposing a finite amplitude helix upon the steady state density and potential. The stability of this system is investigated, and conditions for marginal stability are found as a function of the amplitudes of the superimposed helix. Results of numerical calculations of electric field, wavelength, and frequency as functions of the magnetic field are given for the helical (m = 1) mode for different values of the amplitude parameter. Two sets of solutions are found. One set is singled out and combined with the energy balance theory of the positive column. The results given in plots are compared with experimental data and found to be in qualitative agreement with measurements of electric field, wavelength, and frequency. A hysteresis effect is predicted, and the paramagnetism of the positive column above a certain gas pressure is verified. (auth)

14703 FREQUENCY AND WAVENUMBER SHIFTS FOR NONLINEAR WAVES IN A "HOT" PLASMA. D. A. Tidman and H. M. Stainer (Univ. of Maryland, College Park). Phys. Fluids, 8: 345-53(Feb. 1965).

The perturbation methods of Krylov, Bogoliubov, and Mitropolsky are applied in a generalized form to some cases of wave propagation in a hot electron plasma. Amplitude-dependent frequency and wavenumber shifts are derived from the condition that the perturbation expansions be free of secular terms. (auth)

14704 LOWERING OF THE IONIZATION ENERGY IN A PLASMA WITH DIFFERENT TEMPERATURES. G. Ecker and W. Kroell (Universitat, Bonn). Phys. Fluids, 8: 354-7(Feb. 1965).

The lowering of the ionization energy in a plasma is due to the interaction of all particle components. The magnitude of this effect in the Saha equation of a plasma in thermodynamic equilibrium was treated in a number of investigations. The same problem is studied for a plasma with different temperatures of the particle components. Each component is uniformly distributed in the configuration space and is quasi-Maxwellian in the velocity space. A generalized Saha equation is derived using the methods of irreversible thermodynamics. The lowering of the ionization energy can be calculated with the help of the correlation functions. It is given in terms of particle number density and temperatures. (auth)

14705 MAGNETIC COMPRESSION OF COLLISION-FREE PLASMAS WITH CHARGE SEPARATION. Vernon J. Rossow (Ames Research Center, Moffett Field, Calif.). Phys. Fluids, 8: 358-66(Feb. 1965).

An analysis made previously by Auer, Hurwitz, and Kilb on one-dimensional unsteady magnetic compression waves passing through a cold, collisionless, fully ionized plasma in a direction perpendicular to the ambient magnetic field is extended here to include charge separation. Introduction of a charge attachment parameter, $R_f = (\omega_{pi}/\omega_{ci})^2$, makes it possible to treat the ions and electrons as two separate fluids that are coupled through electric and magnetic fields in the plasma. Changes in the structure of the compressed layer with the charge attachment parameter from the loosely coupled situation, $R_f = 1$, to the one where rigid fastening is assumed, $R_f = \infty$, are illustrated for both a weak and a strong compression wave. A fine structure attributable to electron oscillations in the flow field is found when the two species are loosely coupled. The wavelengths of both the small and large oscillations are associated with the upper and lower hybrid frequencies, respectively. It is also found that ion sheets interchange positions or mix on a large scale, but the electrons do not for moderately strong compression waves. However, both ions and electrons are found to mix if the compression wave is very intense. An approximate rule is presented for the lower limit of the Alfvén Mach number of the wave front at which electron mixing on a large scale is induced. (auth)

14706 FORMATION OF A HIGH-DENSITY DEUTERIUM PLASMA FOCUS. J. W. Mather (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 8: 366-77(Feb. 1965). (LA-DC-5981)

During the early investigation of the high-energy, low-pressure mode of a coaxial hydromagnetic gun, a second mode of action was established for large gas fillings. This particular mode, was found to lead to a high-density plasma focus situated at a distance ~1 to 1.5 cm beyond the face of the center electrode. The plasma focus has the following properties; particle density $\rho \sim 2$ to $3 \times 10^{19}/cm^3$, temperature T ~1 to 3 kev, time duration t ~0.2 to 0.3 μsec, and volume ~15 mm^3. Neutron yields $>10^{10}$/burst and soft x rays are observed. These results are remarkably similar to those reported by Petrov and Filippov using a metal wall pinch tube apparatus. The average velocity v_z of the current sheath in the gun proper is found to depend on the fourth root of the applied voltage squares, divided by the mass density according to the simple "snowplow" "M" theory. The current sheath is found to be nonplanar and mass pickup by the advancing sheath is nonlinear with radius. The sudden collapse of the radial current sheath toward the axis at the center electrode end is most likely caused by the rapid conversion of stored magnetic energy into radial sheath motion ($\dot{v}_r \sim 3.5 \times 10^7$ cm/sec) forming in essence a super dense pinch effect. (auth)

14707 EXPERIMENT ON THE INTRUSION OF PLASMA INTO A SIMULATED MAGNETIC CAVITY. Nobuki Kawashima and Sigeru Mori (Japan Atomic Energy Research Inst., Ibaragi). Phys. Fluids, 8: 378-83(Feb. 1965).

The interaction of a plasma stream with a three-dimensional dipole was experimentally investigated. The time-resolved photographs, magnetic probe and Rogowski coil measurement, and double probe measurement showed the intrusion of plasma in the magnetic cavity. Plasma and current distribution is found to be asymmetric with respect to the plasma gun–dipole line, and the direction of the current in the magnetic cavity corresponds to the westward one around the earth. (auth)

14708 PERPENDICULAR TEMPERATURE OF THE C-STELLARATOR PLASMA. Koji Uo (Princeton Univ., N. J.). Phys. Fluids, 8: 384-7(Feb. 1965).

The perpendicular temperature of the current-carrying plasma of the C Stellarator is measured by means of a diamagnetic coil. The perpendicular temperature and the

resistivity temperature are in substantial agreement with a particle velocity distribution that is essentially isotropic. For the discharge having a long pulse duration and a higher temperature, the distribution differs from isotropic to a small extent; and the discrepancy becomes larger for the period at the end of the discharge. This suggests the production of runaway electrons, and the resistivity temperature would then appear higher than the true temperature. For the period at the end of the discharge, the plasma density becomes very low, while the ohmic heating current is forced to be constant by the external electronic feedback control system. Thus the probability of the generation of the runaway electrons increases. (auth)

14709 SHOCK HUGONIOTS FOR XENON AND KRYPTON. M. McChesney and N. R. Jones (Univ. of Liverpool). Phys. Fluids, 8: 388-9(Feb. 1965).

The density-pressure functions for shock waves in Xe and Kr were calculated for pre-shock conditions of 0.5, 1.0, 3.0, 10 and 20 torr and 288°K and for post-shock temperatures of 7000 to 20,000°K in 1000°K steps. Two plasma models were considered. (D.C.W.)

14710 AFTERGLOW STUDIES IN HYDROGEN. H. J. Oskam and V. R. Mittelstadt (Univ. of Minnesota, Minneapolis). Physica, 30: 2021-30(Nov. 1964).

The time dependence of the electron density during the afterglow period of plasmas produced in hydrogen was measured by means of the microwave cavity method. This time dependence was found to be exponential during the later part of the afterglow period for pressures smaller than 4.5 torr. The relevant time constant depended on the plasma excitation conditions. The mobility value 13.3 ± 0.5 cm^2/volt second calculated from the measured ambipolar diffusion coefficient is believed to refer to H_3^+ ions moving in molecular hydrogen and is in good agreement with the values obtained from time-of-flight studies. The value 16.4 cm^2/volt second obtained with long plasma excitation pulse lengths most probably refers to H^+ ions moving in a mixture of atomic and molecular hydrogen. The studies indicated that one of the hydrogen ions, most probably H_3^+, might have a recombination coefficient equal to or larger than 10^{-7} cm^3 s^{-1}. (auth)

14711 RUNAWAY ELECTRONS IN AN R.F. MIRROR FIELD. H. J. L. Hagebeuk and M. P. H. Weenink (FOM-Instituut voor Plasma-Fysica, Rijnhuizen, Jutphaas, Netherlands). Physica, 30: 2261-4(Dec. 1964).

An analysis of electron containment by two r-f mirror electric fields connected by a constant magnetic field is presented. (D.C.W.)

14712 DETAILED HOT PLASMA SECONDARY SPECTRUM AND INFLUENCE OF PARAMETERS. A. M. Messiaen and P. E. Vandenplas (Ecole Royale Militaire, Brussels). Physica, 30: 2309-13(Dec. 1964).

It was shown experimentally that there exists a number of secondary peaks beyond the so-called series limit. The detailed behavior of these peaks was studied as a function of a steady magnetic field. (auth)

14713 MEASUREMENT OF THE TRANSITION PROBABILITIES OF Ne(I) AND Kr(I) LINES IN THERMALLY LUMINOUS PLASMA. Horst Friedrichs (Universität, Kiel). Z. Astrophys., 60: 176-83(Dec. 1964). (In German)

Transition probabilities of nine Ne(I) lines in the spectral range from 5852 to 6304 Å and of four Kr(I) lines in the range from 4400 to 4502 Å were measured in thermally luminous plasma at atmospheric pressure and at low pressures. (tr-auth)

14714 THE BOUNDARY LAYER PROBLEM IN MAGNETOGASDYNAMIC GENERATORS. Peter Steinkamp (Universitat, Bonn). Z. Physik, 181: 494-531(1964). (In German)

The boundary layer problem in the flow of a compressible viscous heat-conducting plasma at high temperature in the model of a MGD transverse field generator was considered. From the general basic equation system of plasma dynamics, three coupled common boundary layer differential equations for magnetogasdynamics were derived with the help of a dimension consideration. An estimation of the parameter characterizing the problem makes possible a numerical evaluation of the differential equations. The pattern of the electrical field strength in front of the anode or cathode was adjusted. Since the expansion of the velocity and temperature boundary layer in a dimensionless treatment is independent of the characteristic magnitudes of the problem, this boundary layer thickness can serve as a unit for the consideration of the expansion of electrical boundary layers. (tr-auth)

14715 STABILITY OF ROTATING PLASMA WITH TWISTED MAGNETIC FIELD. [PART] II. Pratibha Verma and Y. K. Verma (Univ. of Delhi). Z. Physik, 182: 238-42(1965).

The stability of a uniformly rotating cylindrical plasma configuration in dynamical equilibrium is discussed. Assuming an axial current and sheet currents for the plasma, a dispersion relation for non-axisymmetric perturbations is obtained, which comes out to be a complex and implicit function of the frequency of perturbations. The dispersion equation for the mode m = 1 is discussed with the help of numerical computations. It is shown that rotation has a stabilizing influence, whereas the axial current destabilizes the cylinder. (auth)

14716 THRESHOLD ION ENERGY AT TWO-BEAM ION INSTABILITY. M. D. Gabovich and G. S. Kirichenko. Zh. Eksperim. i Teor. Fiz., 47: 1594-5(Oct. 1964). (In Russian)

It is pointed out that relative motion of an ion beam and plasma or plasma streams can be accompanied by two-beam ionic instability. Oscillations can be excited in passage through the plasma. Experiments performed in order to determine the threshold energy of ions in two-beam instability are described. Ion beams with currents on the order of 1 mamp were passed through plasma formed in different gases, and oscillations excited by the beam at different electron temperatures were observed. It was established that the dependence of the amplitude of the oscillations on the energy of the ions can be represented by a curve which contains a maximum. It was found that in accordance with theoretical predictions, the threshold energy of ions determined from the maxima as a function of the temperature of the ions is proportional to the electron temperature. The frequency of oscillations was determined to be approximately proportional to the velocity of the ions. It is pointed out that the experiments indicate the possibility of using two-beam ionic instability for thermalization of powerful ion beams in plasma with high electron temperature and for plasma diagnostics. (ATD)

14717 TURBULENT HEATING OF PLASMA IN A DIRECT DISCHARGE. M. A. Babykin, P. P. Gavrin, E. K. Zavoiskii, L. I. Rudakov, and V. A. Skoryupin. Zh. Eksperim. i Teor. Fiz., 47: 1597-1600(Oct. 1964). (In Russian)

A direct experiment in which the discharge is produced between end electrodes is reported, aimed at explaining the strong electron heating observed in an earlier investigation and which cannot be attributed to turbulent heating by the magnetohydrodynamic wave. A current was made to flow through a fully ionized plasma with density $\sim 10^{12}$ cm^{-3}, produced by plasma injectors. The plasma was adiabatically compressed by a factor of 25 after heating by the current. The magnetic field at the instant of injector operation and during the direct discharge was 350 Oe, and rose to 9×10^3 Oe at the maximum of compression. The electron temperature estimated from the spectral distribution of the bremsstrahlung is ~ 200 kev, and the ion temperature ~ 3 kev. In addition to the hard bremsstrahlung, neutrons amounting to $\sim 10^5$ per pulse were also recorded. The heating is due to the discharge of an appreciable fraction of the energy of one of the injectors through the plasma along the magnetic field to the other injector, occurring when the electron velocity reaches a certain critical value. The plasma thus produced was contained in the magnetic mirror during the entire lifetime of the magnetic field, approximately 2 msec. (ATD)

14718 FIELD TRANSPORT BY A SHOCK-PRODUCED PLASMA. Ja Hyum Lee. Thesis, Nashville, Vanderbilt Univ., 1964. 114p.

A moving field of ca 50 gauss is observed downstream of a d-c magnetic field up to 34 kG, coupled transversely with a shock-produced plasma flow of velocity up to 5 cm/μsec. The shock tube used is conical and powered by 2.5 μF capacitor bank at 30 kv. The expansion tube has a rectangular section of size 1 × 2 cm, which is inserted between the poles of the magnet. The magnetic field is localized to a 1-cm extent, which is substantially less than the tube width, so that the induced currents have complete paths within the plasma. These current loops appear as a trapped field which is transported downstream by the plasma. The transported field is detected by a set of pickup coils and is found to be anti-parallel to the imposed field and to decay exponentially in time. The decay time of the field gives an estimate of the conductivity, although the effect of cooling complicates the interpretations. The amount of trapped field is in agreement with an approximate theory in which the initial trapped field decay, the magnetic deceleration of the flow, and the reduction of the conductivity by the magnetic field are considered. The trapped field is found to be proportional to the reduced conductivity and the flow velocity. However an increase in the imposed field beyond 17 kG reduces the trapping effect owing to reductions in both the conductivity and the exit flow velocity. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14719 INSTABILITIES OF A Z-PINCH DISCHARGE. Rodney Trevor Hodgson. Thesis, Vancouver, Can., Univ. of British Columbia, 1964. 79p.

Simple rotationally symmetric instability modes were excited in the normally stable initial stage of an argon Z-pinch discharge by means of a set of equally spaced glass rings. High speed framing camera photographs show that the instabilities develop approximately in accordance with the Rayleigh-Taylor theory. No axial drift of the instabilities is observed, but the new technique of studying instabilities reveals that the acceleration of the discharge boundary changes appreciably three or four times during the course of the first stage of the discharge. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14720 RADIATIVE MODES OF A MAGNETOPLASMA SLAB. Gerald Martin Halpern. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1964. 126p.

It is shown that there exist modes of oscillation of a cold magnetoplasma slab which generate outgoing electromagnetic radiation. The dispersion relation that relates the frequency and wavenumber of these modes is derived. An analysis of this equation is made with emphasis on waves having phase velocity greater than light in vacuum. These waves are found to have complex frequencies due to radiation damping. Dispersion curves are drawn for arbitrary values of applied magnetic field. The behavior of these curves is discussed in the transition to an unbounded plasma. Temperature, ion dynamics, and collisions are neglected in the analysis. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14721 RADIAL DISTRIBUTION FUNCTIONS FOR PARTIALLY IONIZED GASES. William Dougless Deering. Thesis, University Park, New Mexico State Univ., 1964. 102p.

It is shown that a consistent theory of a fully ionized gas may be obtained from classical statistical mechanics provided the inaccessibility of bound states is explicitly taken into account in the formalism. This exclusion is found to have the following consequences: (1) the radial distribution function of electrons about ions has the form $g^{+-}(r) = 2\pi(\pi kT)^{-\frac{1}{2}} \int_0^\infty \exp(-E/kT) \times (E + w(r))^{\frac{1}{2}}\, dE$ where E is the internal energy of an electron-ion pair, r is the distance between particles and w(r) is a potential of average force; (2) obtaining w(r) as an iterative solution of the nonlinearized Poisson-Boltzmann equation, the total system potential energy U is found to be finite and different from the Debye-Hückel energy U_D by 10% of U_D if $T = 10^{4\circ}K$ and $n = 10^{16}cm^{-3}$; (3) the kinetic energy per particle is greater than 3kT/2 by 50% of the Debye-Hückel energy per particle. Quantum corrections to these results are shown to be negligible. In a partially ionized gas, bound electrons move in a potential produced by the nucleus as well as the surrounding free charges. The time-averaged distribution of free charge about an atom in a plasma is determined by the field produced by the entire atom. It is shown that the inclusion of the bound electron charge density in a self-consistent scheme leads to an effective potential for the bound electron which is significantly different from the Debye-Hückel potential. A method for extending the accuracy of the radial distribution function by solving the Born-Green equation is also discussed. (Dissertation Abstr., 25: No. 4, Oct. 1964)

14722 VOPROSY TEORII PLAZMY. VYPUSK 2. (Problems in the Plasma Theory. Part 2). M. A. Leontovich, ed. Moscow, Gosatomizdat, 1963. 263p.

Four articles are included on the theory of high-temperature plasma containment by electromagnetic fields. Separate abstracts were prepared for each article. (R.V.J.)

For abstracts of individual sections see: 14723, 14724, 14725, and 14726.

14723 GEOMETRY OF THE MAGNETIC FIELD. A. I. Morozov and L. S. Solov'ev. p.3-91 of "Voprosy Teorii Plazmy. Vypusk 2." Moscow, Gosatomizdat, 1963.

A systematic study was made of the structure of quasi-stationary and static magnetic fields in order to determine their hydrodynamic properties for containment of plasma. The geometry of the toroidal field and the equations for toroidal magnetic surfaces were analyzed. The field with closed circuit lines, direct field with helical symmetry, magnetic field stability, buckling magnetic field, and magnetic fields within special points and lines are discussed. (R.V.J.)

14724 PLASMA EQUILIBRIUM IN A MAGNETIC FIELD. V. D. Shafranov. p.93-131 of "Voprosy Teorii Plazmy. Vypusk 2." Moscow, Gosatomizdat, 1963.

The properties of equilibrium plasma configurations based on the equilibrium equations are described and analyzed. An ideal plasma containment time is considerably longer than the mean time of Coulomb collisions between electrons and ions. The equation system describing the plasma scalar pressure and equilibrium conditions for ideal containment were also used for describing plasma in a quasi-stationary electromagnetic field with relatively slow drift and diffusion motions. In a cylindrical plasma pinch the plasma containment is achieved either by the external field which demands an equilibrium magnetic field configuration or by the current in which case the configuration is achieved by excitation of an electric current in plasma by external field. However, the cylindrical pinch is not a closed system, therefore the studies are confined to the toroidal plasma configuration and other complex equilibrium configurations. (R.V.J.)

14725 HYDROMAGNETIC STABILITY OF PLASMA. B. B. Kodomtsev. p.132-76 of "Voprosy Teorii Plazmy. Vypusk 2." Moscow, Gosatomizdat, 1963.

The hydromagnetic stability of an ideally conducting plasma was studied considering energy principles and equations for weak oscillations in inhomogeneous plasma. It is shown that the convex plasma boundary without frozen-in magnetic fields is unstable while the concave is stable. The instability of plasma, the stability of pinch with a longitudinal current, and the fine skin layer are discussed as well as the stability of a toroidal system and the stability of plasma with a finite conductivity. The instability in a current carrying pinch is studied when plasma conductivity varies in space and when the plasma superheated instability is a function of the temperature. The work on the plasma stability was carried out only in linear approximation (i.e., only in relation to infinitely weak perturbations). (R.V.J.)

14726 MOTION OF CHARGED PARTICLES IN ELECTROMAGNETIC FIELDS. A. I. Morozov. p.177-261 of "Voprosy Teorii Plazmy. Vypusk 2." Moscow, Gosatomizdat, 1963.

The theory of charged particle motion in electromagnetic fields was studied considering the problems of magnetic traps for particles and plasma. The containment of charged particles demanded complex geometry. Therefore, the particle motion was analyzed by approximations and averaging

methods resulting in drift equations. However, in some cases even approximation equations could not be integrated demanding further use of the longitudinal invariant method. The method of approximations complicated the investigation of absolute traps where the condition of unlimited time of particle containment in a trap is of great importance. It is stressed that the use of drift approximations is not satisfactory in studies of hot plasma, mirror traps with injections, stellarators at high temperatures, and other studies of charged particle motion. (R.V.J.)

14727 PRELIMINARY RESULTS OF SCATTERING OF r.f. RADIATION FROM A POSITIVE COLUMN OF A DISCHARGE TUBE. Richard L. Moore and Joseph E. Butterworth (Douglas Aircraft Co., Inc., Long Beach, Calif.). 29p. (CONF-640606-6)

From American Physical Society Summer Meeting, Denver.

Resonant frequencies for vertically polarized incident radiation at 2 to 8 Gc were measured as a function of current, column temperature, and mercury pressure, using a radar anechoic chamber and a positive-column mercury discharge tube. The lowest resonant frequency is consistently larger than the resonant frequency for the same conditions when the plasma tube is mounted across a transmission line. Angular scattering measurements were made, confirming previous results. The scattering cross section is much larger than its geometric cross section, indicating resonant scattering such as in optical anomalous dispersion. The Q of the resonances decreases with frequency, probably due to radiation damping. Electronic sound speeds measured in a wave transmission experiment will be compared to the sound speed derived from the ratios of the resonances and the lowest resonant frequency. (auth)

Shielding

Refer also to abstracts 13695 and 14536.

14728 (APEX-581) SHIELDING TESTS PERFORMED IN THE GENERAL ELECTRIC OUTSIDE TEST TANK IN THE PERIOD MARCH–JUNE 1958. S. T. Friedman (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 87p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Dose and flux data were obtained outside the General Electric Outside Test Tank (OTT) (formerly Outside Tank Facility) when configurations of realistic shield material slabs were in the tank. Tables and graphs of these data are presented. Information is given about secondary gammas, photoneutron production, radiation falloff rate, and other shielding variables. (auth)

14729 (HW-84451) SHIELDING REQUIREMENTS FOR MOXTYL FUELS. L. G. Faust (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 22, 1964. Contract AT(45-1)-1350. 3p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The shielding requirements for a moxtyl (mixed-oxide crystal) fuel assembly, following irradiation to 10,000 Mwd/t, are given for various shielding materials as a function of cooling time and decontamination factor. (T.F.H.)

14730 (MLM-1219) GAMMA SELF-ABSORPTION IN A SPHERICAL DISTRIBUTED GAMMA SOURCE. K. W. Foster (Mound Lab., Miamisburg, Ohio). Nov. 6, 1964. Contract AT-33-1-GEN-53. 10p. Dep.; $1.00(cy), 1(mn) CFSTI.

A precise solution to the self-absorption effect in a thick spherical gamma source was derived. Solutions to the general equation were obtained with the IBM 1620 computer by numerical integration of the relation. An examination of the values obtained showed that for source-to-detector distances greater than 10 times the radius of the source, the self-absorption factor can be represented as $S = (3/2\mu r)[\frac{1}{2} + (e^{-2\mu r}/2\mu r) - \{(1 - e^{-2\mu r})/4\mu^2 r^2\}]$. Tables of this function from $\mu r = 0.02$ through 9.98 are given. (auth)

14731 (TO-B-63-82) MONTE CARLO CODES TO INVESTIGATE THE REFLECTION AND TRANSMISSION OF GAMMA RAYS AND NEUTRONS IN HOMOGENEOUS AND HETEROGENEOUS SLABS. VOLUME II. NEUTRON CODES. Final Report. Dominic J. Raso (Technical Operations Research, Burlington, Mass.). Oct. 17, 1963. Contract DA-18-108-405-CML-1023, CPL-405-13163. 23p. $6.60(OTS).

Vol. I is TO-B-63-73; Vol. III is TO-B-63-83.

A multipurpose gamma ray and neutron Monte Carlo program for describing the emergent (backscattering or transmitted) characteristics of photons or neutrons by slab was written. The program is set up to investigate gamma ray or neutron backscattering, absorption, and transmission in one, two, or three layers of different media. The information that may be obtained includes the number albedo or transmitted, the energy albedo or transmitted, and the angular distribution of the emergent number, energy, or dose. Sample results are given for both incident gamma rays and neutrons. (auth)

14732 (TO-B-63-83) MONTE CARLO CODES TO INVESTIGATE THE REFLECTION AND TRANSMISSION OF GAMMA RAYS AND NEUTRONS IN HOMOGENEOUS AND HETEROGENEOUS SLABS. VOLUME III. RESULTS. Final Report. Dominic J. Raso (Technical Operations Research, Burlington, Mass.). Oct. 17, 1963. Contract DA-18-108-405-CML-1023, CPL-405-13163. 11p. (AD-422456). $1.60(OTS).

See TO-B-63-73 for Vol. I and TO-B-63-82 for Vol. II.

A multipurpose gamma ray and neutron Monte Carlo program for describing the emergent (backscattering or transmitted) characteristics of photons or neutrons by slabs was written. The program is set up to investigate gamma ray or neutron backscattering, absorption, and transmission in one, two, or three layers of different media. The information that may be obtained includes the number albedo or transmitted, the energy albedo or transmitted, and the angular distribution of the emergent number, energy, or dose. Sample results are given for both incident gamma rays and neutrons. (auth)

14733 (WAPD-BT-31(p.43-9)) PENETRATION OF POINT MONODIRECTIONAL GAMMA RAYS THROUGH SLAB SHIELDS. K. Shure (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

A Monte Carlo program, GR-1, was written for estimating the spatial distribution of gamma radiation from a monoenergetic point monodirectional source which penetrates the last face of several slab shields. Results obtained with this program are compared with experimental results and other calculational results. The comparison verifies the validity of the program. (auth)

14734 THE USE OF BUILD-UP FACTORS IN CALCULATING GAMMA RADIATION FROM PLANE SOURCES BEHIND ABSORBER OF FINITE EXTENSION. A. Rudloff (Bundesamt fur Zivilen Bevölkerungsschutz, Bad Godesberg, Ger.). Atomkernenergie, 9: 451-6(Nov.-Dec. 1964). (In German)

The penetration of gamma radiation from plane sources through absorbers of finite extension is calculated by use of a two parametric formula for the build-up factor. The parameters, depending on the quantum-energy of the gamma radiation and the atomic number of the absorber, are adapted to the values of Goldstein and Wilkins in the best way possible. The calculation is made for circular and rectangular plane sources, each for the radiation of ^{60}Co and ^{137}Cs. If the detector is placed vertically under the center of the plane source, the dose rate depends in first approximation only on the solid angle from which the detector face the plane source. For rectangular plane sources, the side-lengths relation of which differs considerably from 1, it is necessary to introduce a corrective factor. The results are compared with experimental data. (auth)

14735 SHIELDING STUDIES IN STEEL WITH 10 AND 20 Gev/c PROTONS. PART I. GENERAL DESCRIPTION OF THE EXPERIMENT. J. Geibel (CERN, Geneva), K. H. Reich, and J. Seetzen. Nucl. Instr. Methods, 32: 45-7(Jan. 1965).

Experiments were performed to study the three dimen-

sional development of the nucleonic cascade induced in steel by 10- and 19.2-Bev/c proton beams and the shielding requirements for secondary particles emerging at 20 to 40° from a Be target bombarded with 10- and 19.2-Bev/c protons. The experimental layout—beam and monitoring, absorber arrangement, and detectors—is described. A qualitative summary of the results is given. (M.J.T.)

14736 SHIELDING STUDIES IN STEEL WITH 10 AND 20 Gev/c PROTONS. PART II. A STUDY OF THE NUCLEAR CASCADE IN STEEL INITIATED BY 19.2 Gev/c PROTONS. A. Citron (Brookhaven National Lab., Upton, N. Y.), L. Hoffmann, C. Passow, W. R. Nelson, and M. Whitehead. Nucl. Instr. Methods, 32: 48-52(Jan. 1965).

The longitudinal attenuation and lateral spread of the nuclear cascade was studied for a pencil beam of 19.2-Bev/c protons incident on a steel absorber. Angular distribution and density of tracks were measured in Ilford emulsion stacks of different thicknesses exposed at different positions. Track and star densities are given as functions of the lateral distance from the beam axis, as functions of absorber thickness along the axis and in lines parallel to the axis, and as functions of absorber thickness for the density integrated over the lateral flux density, all for absorber depths from 0 to 260 cm. Results are compared with those of previous experiments for absorption in heavy concrete, with wide and narrow beam geometries. (M.J.T.)

14737 SHIELDING STUDIES IN STEEL WITH 10 AND 20 Gev/c PROTONS. PART III. MEASUREMENT OF THE NUCLEAR CASCADE AT 10 Gev/c WITH EMULSIONS. R. L. Childers (Oak Ridge National Lab., Tenn.), C. D. Zerby, C. M. Fisher, and R. H. Thomas. Nucl. Instr. Methods, 32: 53-65(Jan. 1965).

Emulsions were exposed to a 10-Bev/c proton beam, attenuated by steel of thickness from 0 to 300 cm. Results of two independent experiments, at ORNL and NIRNS, were compared and found in good agreement. Track lateral profiles at various depths are given. Track peak intensity and integrated intensity, total star density, and fraction of neutral stars are presented as functions of the absorber thickness. (M.J.T.)

14738 SHIELDING STUDIES IN STEEL WITH 10 AND 20 Gev/c PROTONS. PART IV. MEASUREMENTS OF THE PENETRATION OF A 10 AND 19.2 Gev/c PROTON BEAM IN STEEL USING IONIZATION CHAMBERS AND PLASTIC PHOSPHORS. J. Baarli, K. Goebel, and A. H. Sullivan (CERN, Geneva). Nucl. Instr. Methods, 32: 57-60(Jan. 1965).

Attenuation of 10- and 19.2-Bev/c proton beams in steel of 0 to 180 cm thickness was studied. Proton flux was determined from measurements of ^{11}C activity induced in plastic phosphors. Radiation dose measurements were made with air-equivalent condenser ionization chambers. Beam attenuation, lateral flux density, and radiation dose are presented as functions of absorber depth. Mean free paths and build-up factors were calculated from the data. (M.J.T.)

14739 SHIELDING STUDIES IN STEEL WITH 10 AND 20 Gev/c PROTONS. PART V. STUDIES OF THE SHIELDING REQUIRED FOR THE SECONDARY RADIATION PRODUCED BY A TARGET IN A HIGH-ENERGY PROTON BEAM. L. Hoffmann and A. H. Sullivan (CERN, Geneva). Nucl. Instr. Methods, 32: 61-4(Jan. 1965).

A thin Be target was placed in 10- and 19.2-Bev/c proton beams, and the angular distribution of secondary particles emitted between 10 and 90° was determined. The attenuation in steel of this secondary radiation was studied from 20 to 40°. Nuclear emulsions and plastic phosphors were used for detectors. (M.J.T.)

14740 SHIELDING STUDIES IN STEEL WITH 10 AND 20 Gev/c PROTONS. PART VI. MONTE CARLO CALCULATION OF THE NUCLEON MESON CASCADE IN SHIELDING MATERIALS. J. A. Geibel and J. Ranft (CERN, Geneva). Nucl. Instr. Methods, 32: 65-9(Jan. 1965).

Monte Carlo calculations on the three dimensional development of a nucleon-meson cascade in shielding materials were carried out. The results for cascades initiated by incoming protons of 10 and 20 Bev in steel compared favorably with the corresponding experimental results. (auth)

14741 MEASUREMENT AND EVALUATION OF THE ENERGY DISTRIBUTION OF MULTIPLY SCATTERED GAMMA RADIATION IN QUARTZ SAND. Alfred Schaarschmidt (Universität, Frankfurt am Main). Z. Angew. Phys., 18: 167-77(Dec. 15, 1964). (In German)

The energy spectra of multiply scattered γ radiation in quartz sand ($Z_{eff} = 10$) were investigated. Point sources of ^{137}Cs and ^{60}Co, and for preliminary measurements on ^{203}Hg also, were used as radiators, and a single NaI(Tl) scintillation counter was the detector. Source and detector were buried so deep in sand that the conditions of an infinite expanding scattering medium were obtained. The measured distance range was from 10 up to 70 or 90 cm. Methods for evaluation of the measured pulse-height distributions are briefly discussed. The influence of the line broadening of the counter proved to be minor. Correction of the spectra with respect to Compton background and x-ray escape was done by the matrix method with a 45 × 45 matrix. The results were compared with similar measurements of other authors and interpolated theoretical spectra. The measured ^{203}Hg spectra increased, relative to the primary radiation with distance, more than expected, and the reproducibility was not sufficient for a valid deduction. The experimental ^{137}Cs and ^{60}Co curves were somewhat flatter and higher at the upper end than the calculated curves. The deviations are, however, within the limits of error for the measurement and evaluation methods used. The expected systematics of the dependence of the scattering spectra on the distance and primary energy was confirmed: formation of a quasi-radiation equilibrium and decrease of the synthesis factor of the scattered radiation with increasing energy of the primary radiation. (tr-auth)

14742 NEUTRON ATTENUATION IN OPTICALLY THICK SHIELDS. A Report of the Special Panel Discussion of the American Nuclear Society at the 1963 Winter Meeting in New York City, N. Y. on November 20, 1963. R. L. Ashley and W. E. Kreger, eds. (American Nuclear Society, [Hinsdale, Ill.]). 1964. 130p. (ANS-SD-1).

Separate abstracts were prepared for the four papers included on the various solutions of four neutron attenuation problems. (D.C.W.)

For abstracts of individual papers see: 14743, 14744, 14745, and 14746.

14743 THE NAP-1 SOLUTIONS. R. Aronson (New York Univ., New York). p.5-25 of "ANS-SD-1."

The results of calculations of neutron dose rates and radiative capture rates in concrete, lithium hydride, and water (infinite media) for isotropic point sources are presented and compared. The different methods used for the calculations are briefly discussed. (D.C.W.)

14744 THE NAP-2 SOLUTIONS. H. C. Claiborne (Oak Ridge National Lab., Tenn.). p. 26-51 of "ANS-SD-1."

Neutron dose rates, capture rates, spectra, and leakage were calculated for an idealized reactor configuration consisting of a uranium-graphite core 200 cm in radius surrounded by a graphite reflector 60 cm in thickness. The core and reflector are surrounded by 10 cm of iron, simulating a reactor vessel; additional biological shielding is provided by 130 cm of concrete. The calculational methods are described, and the results are presented and compared. (D.C.W.)

14745 THE NAP-3 SOLUTIONS. K. Shure (Westinghouse Electric Corp., Pittsburgh). p.52-77 of "ANS-SD-1."

A water-cooled and -moderated right circular cylindrical core of finite height was considered, above which are located alternating water and iron slabs of various thickness, simulating a thermal-shield reactor vessel region. Neutron capture and dose rates in water, capture rates in iron, and energy spectra were calculated for locations along the core axis. The calculational methods are discussed, and the results are presented and compared. (D.C.

14746 THE NAP-4 SOLUTIONS. H. Gerardo (General Motors Corp., Indianapolis). p.78-89 of "ANS-SD-1."

A small, cylindrical fast reactor of finite height with concentric cylindrical regions of BeO, Fe, vacuum, and LiH was considered. Neutron dose rates and capture rates were calculated as a function of radial distance in the LiH. The radiative capture rates in Fe (below 1 ev) and the total neutron leakage rate out of the final region (LiH) were also obtained. The results are presented and compared, and the calculational methods are discussed. (D.C.W.)

14747 REACTOR SHIELDING. Report of a Panel on Reactor Shielding, Held in Vienna, 9-13 March 1964. (International Atomic Energy Agency, Vienna). Technical Reports Series No. 34. Oct. 1964. 167p. (STI/DOC/10/34). $3.50; S 73,50; (£1.10; F.Fr. 14,-; DM 12,25) (IAEA).

Fifteen papers and four summaries of discussions are presented; separate abstracts have been prepared for all. (T.F.H.)

For abstracts of individual papers see: 14748, 14749, 14750, 14751, 14752, 14753, 14754, 14755, 14756, 14757, 14758, 14759, 14760, 14761, 14762, 14763, 14764, 14772, and 14860.

14748 ACHIEVEMENTS AND PROJECTS IN BELGIUM IN THE FIELD OF REACTOR SHIELDING. H. Dopchie (Centre d'Etudes de l'Energie Nucleaire, Mol, Belg.). p.1-2 of STI/DOC/10/34.

The shielding problems (and their solutions) encountered in the Belgium reactors are summarized. (T.F.H.)

14749 STATUS REPORT—CZECHOSLOVAKIA. B. Stoček (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez) and A. Zbytovský. p.14-20 of STI/DOC/10/34.

Neutron attenuation in graphite–iron and iron–borated graphite lamellar shields is studied, for the configurations used in Czechoslovakian power-reactor studies. (T.F.H.)

14750 SHIELDING RESEARCH IN THE FEDERAL REPUBLIC OF GERMANY. D. Bueneman (Gessellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg). p.21-7 of STI/DOC/10/34.

An outline is presented of collimated-beam studies, bulk shielding experiments, measurements using radiation sources, and theoretical analyses connected with reactor-shielding development in West Germany. (T.F.H.)

14751 SHIELDING RESEARCH IN FRANCE. P. Lafore (Centre d'Etudes Nucléaires, Fontenay-aux-Roses, France). p.28-31 of STI/DOC/10/34.

The French reactor-shielding development program is outlined from an administrative viewpoint. Results of analyses of neutron removal cross sections, diffusion, and nuclear cross sections are noted. (T.F.H.)

14752 WORK AND PROGRAMMES CONNECTED WITH SHIELDING PROBLEMS IN ITALY. A. M. Moncassoli (FIAT, Turin). p.32-6 of STI/DOC/10/34.

Experimental studies of neutron and gamma penetration in laminar shields, as well as the theoretical analysis and development of reliable shielding methods, are described as carried out in Italy. (T.F.H.)

14753 STATUS REPORT OF SHIELDING INVESTIGATION IN JAPAN. M. Shindo (Japan Atomic Energy Research Inst., Tokyo). p.37-56 of STI/DOC/10/34.

Experimental and theoretical shielding studies, computer codes, and experimental facilities are described, as used in Japanese reactor-shielding analyses. (T.F.H.)

14754 SUMMARY OF SHIELDING WORK IN NORWAY. T. Tveten. p.57-62 of STI/DOC/10/34.

Studies of the shielding properties of Fe, boronated plastic, and heavy magnetite concrete are reported. Neutron ages are measured in concrete. Shielding computer programs are described. The water tank of JEEP-II reactor is described. (T.F.H.)

14755 A SUMMARY OF SHIELDING RESEARCH IN SWEDEN. E. Aalto and J. Braun (Aktiebolaget Atomenergi, Stockholm). p.63-78 of STI/DOC/10/34.

A summary is presented of Swedish experimental facilities, bulk shielding studies, and duct and void studies related to reactor shielding. (T.F.H.)

14756 STATUS REPORT ON REACTOR SHIELDING RESEARCH IN SWITZERLAND. J. M. Pictet and E. Etemad (Institut Federal de Recherche en Matiere de Reacteurs, Wurenlingen, Switzerland). p.79-86 of STI/DOC/10/34.

Some problems in reactor shielding design are noted. (T.F.H.)

14757 SHIELDING RESEARCH IN THE UK. A SUMMARY OF THE HISTORY AND CURRENT PROGRAMME OF THE U.K.A.E.A. SHIELDING GROUP WITH AN INDICATION OF FUTURE TRENDS. J. Butler (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.87-97 of STI/DOC/10/34. (AERE-R-3216)

A general approach to problems in neutron attenuation is described. Means for measuring reactor-shield performance are summarized. (T.F.H.)

14758 REACTOR SHIELDING IN THE UNITED STATES OF AMERICA. M. Grotenhuis (Argonne National Lab., Ill.), P. S. Mittleman, and E. P. Blizard. p.98-107 of STI/DOC/10/34.

A summary is presented of radiation sources, radiation-attenuation calculation methods, shielding-performance measurement methods, and shielding-materials evaluations, for applications to reactor shielding design and development. (T.F.H.)

14759 SOME PROBLEMS OF BIOLOGICAL SHIELDING IN REACTORS. Yu. A. Egorov (State Committee for Atomic Energy, Moscow). p.108-34 of STI/DOC/10/34.

The sources and spectra of gamma radiation and neutrons from reactors are investigated. Experimental and analytical methods for optimizing reactor-shielding configurations and materials are discussed. Instruments for these studies are described. (T.F.H.)

14760 STATUS REPORT—ENEA. H. B. Smets (ENEA, Paris). p.135 of STI/DOC/10/34.

The operations of the European Nuclear Energy Agency are described. (T.F.H.)

14761 STATUS OF SHIELDING RESEARCH AT EURATOM ISPRA. H. Penkuhn (EURATOM, Ispra, Italy). p.136-7 of STI/DOC/10/34.

Theoretical and experimental reactor-shielding studies are noted. (T.F.H.)

14762 EXPERIMENTAL FACILITIES AND EXPERIMENTATION. J. Braun (Aktiebolaget Atomenergi, Stockholm), E. Aalto, G. Richter, and A. C. Whittier. p.142-5 of STI/DOC/10/34.

An outline is presented of the major shielding facilities and experiments throughout the world. Instrumentation for shield-performance measurements is also discussed. (T.F.H.)

14763 METHODS FOR CALCULATING RADIATION ATTENUATION IN SHIELDS. J. Butler (Atomic Energy Research Establishment, Harwell, Berks, Eng.), D. Bueneman, A. Etemad, P. Lafore, A. M. Moncassoli, H. Penkuhn, M. Shindo, and B. Stoček. p.146-51 of STI/DOC/10/34.

Diffusion, transport, and Monte Carlo methods for calculating neutron and gamma attenuation by shields, neutron and gamma transmission through shielding ducts, and radiation heating in shields are reviewed. (T.F.H.)

14764 ENGINEERING DESIGN PROBLEMS. J. M. Pictet (Institut Federal de Recherche en Matiere de Reacteurs, Wurenlingen, Switzerland), C. Cortissone, Yu. A. Egorov, P. S. Mittleman, J. Rastoin, and A. Zbytovsky. p.152-5 of STI/DOC/10/34.

An outline is given of problems arising in design optimization, design criteria, and choice of materials for reactor shielding. (T.F.H.)

REACTOR TECHNOLOGY

General

Refer also to abstract 13671.

14765 (ANL-6977) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, NOVEMBER 1964. (Argonne National Lab., Ill.). Nov. 1964. Contract W-31-109-eng-38. 105p. Dep.; $4.00(OTS).

Research and development are reported on spike elements for EBWR, fast reactors, sodium coolant chemistry, EBR-II, FARET, reactor and nuclear physics, high-temperature materials, remote-control equipment, heat engineering, chemical separations, plutonium recycle, Argonne Research Reactor, regenerative emf cells, thermionic cells, and nuclear safety. A list of papers and reports published during the period is included. (J.R.D.)

14766 (HW-81984) RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT. Quarterly Progress Report, January–March 1964. J. K. Green, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. 172p. Dep.; $5.00 (OTS).

Research and development are reported in sections on analytical studies and advanced concepts, chemical research and development, fuel studies, gas-cooled reactor studies, instrumentation and nondestructive testing, radiation effects on materials, corrosion and heat transfer, physics, and Plutonium Recycle Test Reactor. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 13421, 13524, 13702, 13883, 14084, 14788, 14806, 14831, and 14832.

14767 (KR-86) QUARTERLY PROGRESS REPORT, JULY–SEPTEMBER 1964. (Norway. Institutt for Atomenergi, Kjeller). Dec. 1964. 36p. Dep.(mn).

The operation of Jeep and Nora reactors and the development and construction of Jeep II reactor are discussed. The development of mathematical codes and models for boiling water reactors is reported. Production methods for urania pellets are analyzed. The evaluation of thin-walled stainless steel tubing as canning material for fuel elements proceeds. The corrosion of steel and aluminum by water and steam is studied. One fuel element was dissolved in the reprocessing pilot plant and two extraction runs were made. An automatic liquid scintillation method was employed for the analysis of plutonium, and new methods for plutonium purification were tried. Some leaching experiments were performed on solidified mixtures of cement-waste solutions. The production and uses of radioisotopes are outlined. The health physics programs are discussed. (N.W.R.)

14768 (WAPD-BT-31) BETTIS TECHNICAL REVIEW. REACTOR TECHNOLOGY. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Nov. 1964. Contract AT-11-1-GEN-14. 90p. Dep.; $3.00(cy), 2(mn) OTS.

Separate abstracts are prepared for the nine papers presented. (C.E.S.)

For abstracts of individual papers see: 13534, 14470, 14471, 14733, 14794, 14845, 14846, 14847, and 14848.

14769 (WASH-1043) PROPOSED NUCLEAR FISSION REACTOR CONCEPT CLASSIFICATION SYSTEM. William A. Robba and Frank Kerze, Jr. (Division of Reactor Development, AEC). [nd]. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A classification scheme is proposed for nuclear reactors, comprising classifications according to neutron state, energy, and economy; fuel form; cooling mechanism; fissile and fertile materials used; moderator; and reactor purpose. (T.F.H.)

14770 NUCLEAR PROGRAMMING. Giuseppe Zamparo (Universita, Genoa). Calore, 35: 450-62(Oct. 1962). (In Italian)

Reactor construction and operation in the United States and Europe are correlated with past estimates of the energy needs, various reactor types, and economic considerations. (J.S.R.)

14771 NUCLEAR CALCULATIONS FOR LOADING AND UNLOADING OF REACTORS. J. Darvas (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 29-31(Jan. 1965). (In German)

The loading-unloading method is determined by the problem of screening of the reactor plugs or inserts. Calculations are presented for the activation, screening, and nuclear heating. (D.L.C.)

14772 SOURCES OF RADIATION IN REACTORS. M. Grotenhuis (Argonne National Lab., Ill.), H. Dopchie, H. Smets, and U. Tveten. p.139-41 of STI/DOC/10/34.

Primary and secondary radiation sources in reactors are discussed. (T.F.H.)

Auxiliaries and Components

Refer also to abstracts 13520, 13974, 14747, 14748, 14750, 14753, 14754, 14755, 14756, 14757, 14758, 14759, 14760, 14761, 14762, 14763, and 14764.

14773 (CRFD-1207) A FINAL SPECIFICATION FOR THE NEW X-4 LOOP. A. D. Lane, M. J. Watts, V. C. Orpen, and G. M. Allison (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1964. 10p. (AECL-2142). Dep.; $0.50(AECL).

The design specifications are outlined for a rebuilt X-4 loop which will be capable of cooling experimental fuel with either pressurized water, boiling water, an injected steam water mixture, or superheated steam. The loop will also be capable of operation in a once-through mode (subcooled water at inlet to superheated steam at exit) as a result of the above capabilities, although no requirements are specified for this mode of operation. The loop will provide mass flows up to 820 kg/hr in superheated steam, and 1400 kg/hr in fog at 50 wt % quality. It will be designed for a system pressure of 140 kgf/cm^2 and exit steam temperatures up to 570°C. Portions of the loop piping will be fabricated from mild steel, both to reduce the cost of the facility and to provide data on the performance of mild steel systems. The facility will have a high degassing efficiency to allow the simulation of a direct cycle reactor cooling system. A number of commissioning tests are also specified for the loop. (auth)

14774 (IITRI-578P22-12) STUDIES OF REACTOR CONTAINMENT STRUCTURES. Bi-Monthly Progress Report. R. L. Chiapetta and M. A. Salmon (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Dec. 1964. Contract AT(11-1)-578. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The response of thin shell containment vessels to internal pressure loadings is studied. The results of the tests of circular plates with reinforced openings are compared with theory. The agreement between theory and experiment is good except that the measured burst pressures for the heavy reinforced plates are considerably below the predicted values. The heavy reinforcements reduce the ductility of the plates so that failure occurs well below the theoretical instability pressure. (N.W.R.)

14775 (SAN-8002) PROCEEDINGS OF THE SODIUM COMPONENTS INFORMATION MEETING HELD IN PALO ALTO, CALIFORNIA, AUGUST 20-21, 1963. (San Francisco Operations Office, AEC and General Electric Co. Atomic Power Equipment Dept., [San Jose, Calif.]. Con-

tract [AT(04-3)-189]. 316p. (CONF-258). Dep.; $7.00 (OTS).

Sixteen papers are included; separate abstracts have been prepared for 12. Four papers were previously abstracted in NSA, Vol. 18, as abstracts number 1245, 21571, 30990, and 33106. (T.F.H.)

For abstracts of individual papers see: 13204, 13205, 13570, 13581, 13582, 13599, 13916, 13998, 14839, 14840, 14841, and 14842.

14776 REACTIVITY OPTIMUM COMPENSATION IN A MULTIZONE REACTOR FROM THE POINT OF VIEW OF MAXIMUM POWER PLANT OUTPUT. Josef Schmid and Vaclav Stach (Inst. of Nuclear Studies, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 10: 439-43 (Dec. 1964). (In Czech.)

The problem of exploiting a given compensation rod system during normal reactor operation (i.e., how to choose the sequence and insertion depth of individual rods) in order to minimize electrical output loss is discussed. Basic relations for determining the thermal output of the given technology channel as function of the insertion depth of the neighboring rod are given. The problem is solved both for the case of a constant gas flow in the channel and for such channel flow to retain the maximum permissible fuel element temperature. Some functions are introduced to characterize the relative electric output loss referred to the relative absorption rod efficiency. According to the course of these functions both optimum insertion depth of the absorption rod and optimum rod insertion sequence in a multizone reactor may be determined. (P.C.H.)

14777 CHARGING AND DISCHARGING DEVICES AT REACTORS. A SURVEY. M. Pollermann (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 6: 493-5(Nov. 1964). (In German)

A survey is made of typical loading and unloading devices for fuel elements for research and production reactors, horizontal and vertical experiment channels, and irradiation facilities for different reactor types. 51 references. (L.B.S.)

14778 REFUELLING AT TRAWSFYNDD: FAIREY ENGINEERING'S CHARGE MACHINE. Nucl. Eng., 10: 13-17(Jan. 1965).

The self-contained fuel handling machines of the Trawsfynydd power station are described. (D.C.W.)

14779 IMPROVEMENTS IN OR RELATING TO STAND PIPES FOR NUCLEAR REACTORS. Derek Bromley (to United Kingdom Atomic Energy Authority). British Patent 976,137. Nov. 25, 1964. Filed Dec. 21, 1962.

Standpipe design for a gas-cooled reactor contained in a prestressed concrete pressure vessel is patented. The standpipe, lined with thermal insulation, is connected with a channel in the reactor and has two, three, or four coolant-carrying means symmetrically disposed around it and in contact with it. Each coolant-carrying means consists of one or more pipes whose axes are substantially parallel to the axis of the standpipe through that part of the vessel containing prestressing cables. (A.G.W.)

14780 IMPROVEMENTS IN OR RELATING TO MACHINES FOR EFFECTING MOVEMENTS OF RADIO-ACTIVE ELEMENTS THROUGH APERTURES BETWEEN THE INTERIOR AND THE EXTERIOR OF A CHAMBER ADAPTED TO CONTAIN RADIO-ACTIVE ELEMENTS. (to Babcock & Wilcox Ltd.). British Patent 976,347. Nov. 25, 1964. Priority date July 11, 1960, Germany.

A nuclear reactor suitable for mobile use, such as a marine-based reactor, and a charge machine for loading and unloading fuel for such a reactor are patented. The normally closed passageways through the pressure vessel enclosing the reactor for charging and discharging of radioactive fuel elements have respective axes intersecting at a pivot point outside the vessel. The passageways terminate in planes tangential to a common spherical surface centered at the pivot point. The charge machine includes a container for radioactive elements, coupling means for effecting a substantially fluid-tight joint between the ends of the passageways and the container, and means for transferring the elements. It is mounted for universal pivotal movement about the pivot point in such a manner as to make possible alignment of the container with any one of the passageways. The container is provided with known storage means and shielding, and can be used in connection with any mobile storage vessel for radioactive materials. (A.G.W.)

14781 FUEL CHARGING/DISCHARGING SYSTEM FOR GAS COOLED NUCLEAR REACTOR. Everett Long, Gordon Packman, Herbert Chilvers Knights, and Ernest Edward Jerkins (to United Kingdom Atomic Energy Authority). U. S. Patent 3,158,544. Nov. 24, 1964. Priority date June 3, 1959, Great Britain.

The refuelling machine described is intended for use with a gas-cooled reactor in which the gaseous coolant is circulated under pressure in a closed circuit. The machine includes a normally closed circuit in which gaseous coolant, the same as that used in the reactor, can be circulated under pressure. The coolant circuit of the machine can be joined to the reactor coolant circuit in such a manner that the fuel element discharged from the reactor by the refuelling machine can be cooled in its passage from the reactor core into the machine and while it is temporarily housed in the machine. (A.G.W.)

14782 SAFETY DEVICES FOR NUCLEAR REACTORS. Peter Harris Jones (to Rolls-Royce and Associates Ltd.). U. S. Patent 3,158,545. Nov. 24, 1964. Priority date June 25, 1959, Great Britain.

The safety device described is intended for use with the class of nuclear reactor in which the absorber elements are moved vertically between their operative and inoperative positions under scram conditions. Locking elements to retain the absorber elements against substantial displacement from their operative positions become operative on tilting of the reactor from its normal position through a preselected angle. In a preferred form the elements are of the jamming ball type. The device is particularly intended for use with a reactor on a craft such as a submarine where tilting is to be expected. (A.G.W.)

14783 NUCLEAR REACTOR CONTAINMENT METHOD AND APPARATUS. Roland Cordova (to Kaiser Industries Corp.). U. S. Patent 3,158,546. Nov. 24, 1964. Filed Oct. 21, 1960.

A method and apparatus are described for use in the containment of radioactive gases and/or liquids accidentally liberated under high pressure from the primary loop of a nuclear reactor assembly. A quantity of one or more hygroscopic chemicals sufficient to absorb the maximum quantity of fluid that might be liberated is disposed at a preselected location inside the reactor containment vessel. The chemical is normally isolated from the atmosphere by a seal responsive to changes in the atmosphere caused by fluid liberation. Preferably the chemicals used should also have endothermic and deliquescent properties to provide additional capacity for condensation and absorption of pressure-causing gas, water vapor, or steam. Special receptacles for the chemicals are designed to expose maximum surface area and to facilitate collection of the liquefied compounds. (A.G.W.)

14784 METHODS AND DEVICES FOR DETECTING THE PRESENCE OF FISSION PRODUCTS IN THE COOLANT FLUID STREAMS OF A NUCLEAR REACTOR. Rene Donguy and Jean Megy (to Commissariat à l'Énergie Atomique). U. S. Patent 3,161,569. Dec. 15, 1964. Priority date Dec. 2, 1959, France.

A method and a device are patented for monitoring the radioactivity level in reactor coolant streams in order to detect possible fuel can bursts. The method consists of grouping the coolant flow channels into several square matrices of lines and columns. Controls and switches are so arranged as to effect a line-by-line and column-by-column scanning of all the channels. When a defective channel is detected by either the line or channel detector, that channel is continuously supervised by that detector until the defect is located exactly by the other detector.

The method requires fewer detectors, conduits, and switches than previous methods. (A.G.W.)

Criticality Studies

Refer also to abstracts 14745 and 14805.

14785 (AEEW-R-398) THE MEASUREMENT OF SUBCRITICAL REACTIVITY IN NUCLEAR REACTORS BY USE OF HIGH FREQUENCY SINE-WAVE MODULATED NEUTRON SOURCE. C. B. Guppy (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Nov. 1964. 71p. Dep.; $2.00(BIS); 10s. (HMSO).

The frequency response characteristics for phase and gain of the fundamental reactor mode of the zero power kinetics are given for various subcritical reactivities in a fast reactor and in a thermal reactor. Results of a study on harmonic effects based on a small zero energy thermal reactor are presented which demonstrate the importance of spatial harmonic effects. A harmonic theory for thermal reactors is developed. A new method of measuring subcritical reactivity at moderately high frequencies is suggested which circumvents the harmonic problem. It is shown that at high frequencies there is more sensitivity than at low frequencies and that this could lead to an increased range over which subcritical reactivity can be measured. (auth)

14786 (CRRP-1184(App.1)) PERIGEE COMPUTER CODES FOR REACTOR SIMULATION IN 3 DIMENSIONS, USING 1 OR 2 NEUTRON VELOCITY GROUPS. APPENDIX 1. A. P. Olson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1964. 132p. (AECL-2095). $3.00 (AECL).

Modifications to auxiliary routines of PERIGEE are described which extend the generality of the reactor model, change the logic in the equilibrium calculation, and improve the presentation of results. A translation of PERIGEE from machine language (SNAP) to an algebraic language (APEX-IV) was performed. The resultant code, PERIGEE APEX, is discussed in detail. (auth)

14787 (HW-80968) USER'S MANUAL FOR HFN AND CALX CHAIN. E. L. Kelley, Jr. (General Electric Co. Hanford Atomic Operation, Richland, Wash.). Mar. 16, 1964. Contract AT(45-1) 1350. 91p. Dep.(mn); $3.00 (cy), 2(mn) OTS.

Instructions concerning the use of the physics chain are presented. An attempt is made to identify computer programs with the links they occupy on the Physics Chain Tape (PCT) and give some explanation of the tapes and their usage. The PCT was made to enable the use to analyze data for a reactor or cell type problem. This is accomplished in three steps. A neutron flux spectrum for the problem is generated from a reference set of cross sections on a relatively fine energy mesh, and a set of microscopic group cross sections is found for this spectrum. These group cross sections are used as input to special programs for generating data tapes. These data tapes are used by computer programs that solve multigroup, multiregion diffusion or burnup problems. (C.E.S.)

14788 (HW-81984(p.10.1-15)) PHYSICS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Development of a set of physics calculation methods for water-moderated, epithermal, enriched-Pu-fueled reactors is reported. The procedures are incorporated in a burn-up code, ZODIAC. Theory-experiment correlation work is being carried out. A description of the methods is included along with results of criticality calculations, analyses of thermal group constants, and burn-up calculations. (J.R.D.)

14789 (IDO-16928) IREKIN—PROGRAM FOR THE NUMERICAL SOLUTION OF THE REACTOR KINETIC EQUATIONS. R. J. Wagner (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Mar. 1, 1963. Contract [AT(10-1)-205]. 78p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The IREKIN program provides a numerical solution of the ordinary, space-independent differential equations that describe the power behavior of a reactor in response to an arbitrary function of reactivity. The program also yields numerical solutions to other ordinary differential equations that might be used to describe a particular reactor system. (T.F.H.)

14790 (KAPL-2165-2) KARE: A SYSTEM OF DIFFUSION THEORY PROGRAMS FOR THE PHILCO 2000. VOLUME II. GROUP CONSTANT AND DEPLETION CALCULATIONS. D. E. Goodman, P. V. Oby, and W. H. Turner (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1964. Contract W-31-109-eng-52. 109p. Dep.(mn); $4.00(cy), 2(mn) OTS.

The KARE System provides semiautomatic reactor-lifetime calculations of neutron group constants, criticality, spatial distribution of neutron fluxes and fission sources, fuel and poison depletion, and perturbation calculations in one, two, and synthesized three-dimensional geometry. Calculation of group constants for two, three, or four energy groups is provided by the FICS program. Three-dimensional calculations are provided through the synthesis of two-dimensional results by the CLAG program or by RZ synthesis techniques. The coupling between planar problems is provided primarily through self-shielding factors, rod absorption factors, and CLAG transfer coefficients. These quantities are least-squares fitted as a function of fuel or poison depletion by the FLOCK program. Life-study capability is provided by the incorporation of the depletion program in KARE. Burnup occurs in ^{235}U fuel and in various poisons. (auth)

14791 (KAPL-M-6431) KWIP4—KINETICS WITH PLOTTER. Gerhard O. Mueller (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 7, 1964. Contract W-31-109-eng-52. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

KWIP4 is a digital computer program which calculates the excess reactivity, Δk, as a function of time using time-dependent reactor flux data as input. Two and six delay group parameters are built into the program although an input option allows the user to provide his own delay group if so desired. The excess reactivity is obtained through the solution of the time-dependent reactor kinetics equations. The KAPL Calcomp Plotter routine is included as an output option for automatic plotting of the results. The average running time is one second per five data points. (auth)

14792 (KFK-217) THE KARLSRUHE FAST-THERMAL ARGONAUT REACTOR CONCEPT. H. Meister, K. H. Beckurts, W. Haefele, W. H. Koehler, and K. Ott (Kernforschungszentrum, Karlsruhe, Germany). June 1964. 39p. Dep.(mn).

The Fast-Thermal Argonaut Reactor STARK is a flexible zero-power facility suitable for various fast neutron experiments. A fairly subcritical uranium metal zone is driven by a surrounding thermal Argonaut core; according to four-group calculations, an asymptotic fast reactor spectrum is attained in the central region of the assembly, while a high degree of inherent reactor stability is guaranteed by the self-limiting properties of the light-water moderated Argonaut core, provided that the ratio of fission rates in both regions is properly limited. (auth)

14793 (ORNL-3757) SPECULATIONS ON THE INTERPRETATION OF NEUTRON NOISE EXPERIMENTS. R. K. Osborn (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 77p. Dep.; $3.00(cy), 2(mn) CFSTI.

A review is presented of a series of lectures on neutron-noise theory as it is applied to the interpretation of power spectral density measurements in nuclear reactors. Only simple systems, e.g. infinite homogeneous media and bare homogeneous reactors, are considered. The effects of the detector itself upon the measured values are discussed. (T.F.H.)

14794 (WAPD-BT-31(p.59-68)) CORRELATOR FOR EXTRACTING ROD OSCILLATOR SIGNALS FROM NOISE. K. J. Chock (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

An electronic cross-correlator was developed which determines the response of a reactor to rod oscillations over the range of 0.01 to 10 cycles per second, even when considerable noise energy exists at the oscillator frequency. This device requires no modification of the rod oscillator or reactor instrumentation. The quadrature component, cos ωt, required for phase shift measurements is generated internally. The apparently contradictory filter requirements of ultra-low cutoff frequency and fast transient response were satisfied by the use of an active filter in which the cutoff frequency can be reduced in the course of the tests without disturbing the measurements. A laboratory proof-of-principle test was successfully conducted with a signal-to-noise ratio of unity. (auth)

14795 HYDRAULIC INSTABILITY IN BOILING WATER REACTORS. Toshiro Terano (Tokyo Inst. of Tech.), Kenji Kurosu, Yujiro Murayama, and Yukiteru Okumura. Bull. JSME (Japan Soc. Mech. Engrs.), 6: 539-48(Aug. 1963). (In Japanese)

Attempts were made to clarify the mechanism of hydraulic instability in the operation of BWR. Experiments were made using an electrically heated natural circulation loop with electric-condenser type void meters. It was concluded that the hydraulic instability is a kind of nonlinear oscillation caused by the combination of the fluid kinetics in the heated section and the nonlinearity of the friction loss of the two-phase flow. A block diagram of the circulation loop, in which fluid kinetics are simulated with simple linear transfer functions except for the friction-loss term, is derived analytically. The solutions, calculated on an analog computer, agree well with the experimental results. (auth)

14796 CONTROLLING THE MARGIN OF SUB-CRITICALITY OF A WATER REACTOR—A METHOD OF MEASUREMENT ANALYSIS. Gianfranco Eletti and Renato Zambrini. Comit. Nazl. Energia Nucl., Notiziario, 10: No. 11, 23-30(Nov. 1964). (In Italian)

A method for the analysis of experimental data which seems to reduce considerably the uncertainty in subcritical reactivity measurements. Details are given on the experiment made during the first charging of the Senn Reactor on the intermediate core comprising 64 stainless steel elements. (auth)

14797 ON THE FISSION PRODUCT POISONING IN THERMAL REACTORS. V. Benzi and A. Chiarini (C.N.E.N., Bologna). Energia Nucl. (Milan), 12: 44(Jan. 1965).

Previous experimental data and theoretical predictions on fission-product build-up in fuel materials are compared. Thermal cross sections and resonance integrals for pseudo fission products are given for ^{233}U and ^{235}U. Effective absorption cross sections of stable fission products are calculated for two values of the spectral indices for ^{233}U and ^{235}U, using a previously developed formula. (M.J.T.)

14798 THEORETICAL ANALYSIS OF LIGHT-WATER MODERATED REACTOR EXPERIMENTS. Kazuko Yamamoto and Stoichi Terasawa (Hitachi Seisakusho Central Lab., Japan). Hitachi Hyoron, 45: 911-15(June 1963). (In Japanese)

To evaluate reactor parameters, Deutsch's analytic method (Nucleonics, 15: 47(1957)) was expanded with regard to the fast neutron fission effect, effective resonance integral, Fermi age, economy of reflector, etc., and a survey code was prepared. A good agreement was shown between experimental data and the theoretical computation for the critical mass and lattice parameters. The temperature constant was found to be very small, and it was concluded that this analytic method was too simple to deal adequately with it. (BBB)

14799 OPTIMIZATION STUDIES IN NUCLEAR ENGINEERING. Zoltan Rezsoe Rosztóczy. Thesis, Tucson, Ariz., Univ. of Arizona, 1964. 90p.

In 1956, the hypothesis of a mathematical principle by L. S. Pontryagin led to the development of a new optimization technique. This method came to be known as the Maximum Principle and is capable of maximizing an arbitrary functional of the system and control functions. The Maximum Principle is here applied to problems in nuclear engineering. The problems treated are (1) xenon poisoning, (2) reactor kinetics, and (3) optimal fuel distribution in nuclear reactors. The buildup of xenon poisoning is a prime factor in restarting a high flux thermal reactor after shutdown. The amount of excess reactivity required to override the xenon poisoning can be minimized by determining an optimum reactor shutdown program. Based on the Maximum Principle, optimum shutdown programs are determined for various flux levels. Openloop control functions are determined for reactor control processes with minimum control rod movement and with minimum control energy. Power level changes in minimum time and start up of nuclear space systems with minimum auxiliary energy are also discussed. In the design of a nuclear reactor an important criterion is to determine the distribution of fuel in a given reactor such that the reactor would be critical with a minimum amount of fuel. A new approach to the problem is presented by the application of the Maximum Principle and the technique is applied to both homogeneous and heterogeneous reactors. (A.G.W.)

14800 XENON-135 INDUCED INSTABILITIES OF THE NEUTRON FLUX IN NUCLEAR REACTORS. Gary Marlin Sandquist. Thesis, Salt Lake City, Univ. of Utah, 1964. 296p.

The kinetic equations that account for the flux, xenon, and iodine in a space-independent reactor model are examined by various techniques, which include linearization by first order perturbation approximations, high flux level approximation, phase plane analysis, time derivative analysis, and digital and analog computer simulation. The criteria for stability are determined and corroborated by computer simulation and analytic means. It is deduced that, in general, the use of space-independent kinetics is highly restrictive, predicting a threshold value for instability of the flux of 1.5×10^9, and unwarranted in examining most physical reactor systems for xenon-induced flux instabilities. The "P_1" approximations to the neutron transport equation are extended to account for xenon dependence, and approximate solutions are given for the stationary flux distribution. The "P_1" approximations and the diffusion equation are also examined for compatibility, and the expressions for the material buckling and the diffusion coefficient are found and compared. By employing the stability criteria previously established and simulating the space- and time-dependent kinetic equations for one and two energy groups of neutrons the stability of the axial power distribution of the Advanced Test Reactor is examined. On the basis of present design parameters the axial power distribution is deemed stable. A possible method for experimental simulation and examination of xenon-induced flux instabilities employing the Advanced Test Reactor Critical Facility is given. (A.G.W.)

Design and Feasibility

14801 PLANNING OF THE HELIUM CIRCULATING SYSTEM OF A HIGH-TEMPERATURE REACTOR. PART II. F. Helfrich, J. Schoening, and W. Fluegger (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). Atomwirtschaft, 10: 43-7(Jan. 1965). (In German)

In planning the helium circulatory system of a high-temperature reactor safety arrangements and attainment of safe operation through the use of operationally safe components, assembly questions, corrosion protection, and preservation of parts of the installation during transport are considered. Reference is also made to constructural measures that arise from the necessity of making various components in a contaminated situation. (auth)

Fuels

Refer also to abstracts 13874, 13875, 13877, 13884, 13886, and 14817.

14802 (CONF-631201(p.32-5)) PRIVATE OWNERSHIP OF NUCLEAR FUELS. Sherman R. Knapp (Connecticut Light and Power Co., Hartford).

Testimony given before the Joint Committee on Atomic Energy on the private ownership of nuclear fuels is quoted and discussed. (C.E.S.)

14803 (CONF-654-26) LEAST SQUARES VARIATIONAL ANALYSIS OF THE BURNUP PROBLEM. Martin Becker (Knolls Atomic Power Lab., Schenectady, N. Y.) and Henri Fenech (Massachusetts Inst. of Tech., Cambridge). [1964]. Contract W-31-109-eng-52. 14p. Dep. (mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A homogeneous, bare-slab reactor is considered that has a single fuel and is controlled by a variable uniform poison. One-group theory is used to describe the neutron behavior. The fuel burnup in this reactor is calculated by least-squares variational techniques. The FEVER computer code is used for the calculations. (T.F.H.)

14804 (DPST-64-83-11) USAEC-AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, NOVEMBER 1964. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Dec. 21, 1964. Contract AT(07-2)-1. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In a heavy-water-moderated boiling-light-water-cooled power reactor, the amount of light water poison in the fuel coolant channels would be minimized to limit the reactivity changes associated with vaporizing the coolant. This can be achieved by operating with closely spaced fuel rods and high outlet steam qualities. The results show that the burnout heat flux in two-phase flow varies inversely with mass velocity as expected. The tests were made with 0.050-in. diametral clearance between rods and with partial heat generation in the surrounding mockup. The phenolic-silica-fiber ribs that maintain the rod spacing performed well, and tests are continuing. Specifications for plutonium-uranium fuel bundles are given. The specific orientations of hydride platelets in the six types of Zircaloy tubing measured with a new automatic analyzing instrument agreed qualitatively with previously published data. The frequency distribution curves dramatically illustrate the stress orientation of hydride platelets. (N.W.R.)

14805 (HW-81259) NEUTRON KINETICS PROBLEMS ASSOCIATED WITH MIXED OXIDE FUELS. R. E. Peterson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1964. Contract AT(45-1)-1350. 49p. Dep.; $3.00(OTS).

Calculations are presented that estimate Doppler, self-shielding, and fuel-slump reactivity effects as functions of fuel homogeneity and density, for reactors fueled with PuO_2-UO_2 mixtures. The kinetic characteristics of such fuel mixtures during excursions are analyzed. (T.F.H.)

14806 (HW-81984(p.5.1-55)) FUELS STUDIES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Research is reported on irradiation of plutonium ceramics, induction sintering of UO_2, irradiation of UO_2 single crystals, thermal stability of nitrides, hardness of UN single crystals, mechanical properties of $W-UO_2$ cermets, properties of Sm_2O_3 and Nd_2O_3, irradiation of Th–U fuels, corrosion of Th-contaminated braze alloys, Th defect testing, Th–Zircaloy-2 bond strength, and fabrication of Zircaloy-2-clad Th–U–Zr alloys. Research is also reported on PRTR and EBWR fuel fabrication, and pneumatic impaction of clad cermets. In fuels testing and analysis, PRTR fuel element performance and Al–Pu and UO_2 radiation stability were established. Work was continued on impact corrosion element design, impact corrosion of PRTR elements, ThO_2-PuO_2 irradiation, fuel element rejuvenation, irradiation of high-heat-flux fuel rod, irradiation of surface-roughened test elements, irradiation of molten UO_2, and irradiation of EBWR prototype fuel rods. (J.R.D.)

14807 (KAPL-M-6186(Rev.I)) KARE INPUT. J. L. Fletcher (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 1964. Contract W-31-109-eng-52. 45p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Revised inputs for the KARE neutron-diffusion program are summarized. (T.F.H.)

14808 ON THE THERMOELASTOPLASTIC STABILITY OF NUCLEAR FUEL PLATES. B. Guerrini (Universita, Pisa, Italy). Energia Nucl. (Milan), 12: 17-25(Jan. 1965). (In Italian)

The thermoelastoplastic behavior of some rectangular plates is analyzed. Such plates simulate nuclear fuel elements subjected to given symmetrical temperature distributions. Diagrams show the thermal critical buckling conditions. Experimental results are compared with data obtained through a theoretical analysis. (auth)

14809 SYSTEM FOR THE DIRECT PRODUCTION OF ELECTRICITY IN ATOMIC REACTORS. Rainer Gunther. U. S. Patent 3,161,786. Dec. 15, 1964. Priority date Mar. 19, 1960, Germany.

The thermionic reactor patented consists of an emitting electrode heated by fission and a cold collecting electrode opposite to and electrically insulated from the emitting electrode. A carrier base in electrical contact with the emitting electrode on the side opposite the collecting electrodes encloses the fissionable material and has good electrical conductivity at high temperatures. A current conductor in contact with the side of the base opposite the emitting electrode is formed of at least two contacting layers separated transversely to the direction of current flow. The layer next to the base is formed of a material highly resistant to heat, and the other layer of a less heat-resistant material having a higher ratio of electrical to thermal conductivity than the layer next to the base. Connected with the base is a plate with a reflective surface facing the base. Several of these arrangements may be connected in series to produce a higher voltage. (A.G.W.)

Power and Power-Breeder Reactors

Refer also to abstract 14749.

14810 (CONF-631201) PROCEEDINGS OF THE FAST NEUTRON BREEDER REACTOR CONFERENCE, DECEMBER 2-3, 1963, DETROIT, MICHIGAN. (Detroit Edison Co., Detroit). 89p.

The development of fast breeder reactors and plutonium fuel technology are discussed. Separate abstracts are prepared for each of the 14 papers presented. (C.E.S.)

For abstracts of individual papers see: 13521, 13873, 14802, 14811, 14812, 14813, 14814, 14815, 14816, 14817, 14818, 14819, 14820, and 14821.

14811 (CONF-631201(p.9-16)) THE ENRICO FERMI FAST NEUTRON BREEDER REACTOR. DESCRIPTION AND OPERATION. John F. Anderson (Power Reactor Development Co., Detroit).

A description is given of the reactor containment building, design operating conditions, heat utilization system, core and blanket subassemblies, control rods, reactor vessel, fuel transfer cask car, and fuel and repair building. (C.E.S.)

14812 (CONF-631201(p.16-22)) THE ENRICO FERMI FAST NEUTRON BREEDER REACTOR. COMPONENTS-EXPERIENCE TO DATE. Alfred Amorosi (Atomic Power Development Associates, Inc., Detroit).

A review is given of the operation experience with the reactor, and specific problems encountered and the way in which they were handled are outlined. Mechanical design, fuel handling, seals, pump and check valve, steam generator, remote maintenance, and corrosion are discussed. (C.E.S.)

14813 (CONF-631201(p.22-7)) THE ENRICO FERMI FAST NEUTRON BREEDER REACTOR. NUCLEAR EX-

PERIENCE TO DATE. Charles E. Branyan (Atomic Power Development Associates, Inc., Detroit).

Results of low-power nuclear tests on the Fermi Fast Reactor are presented. Measurements were obtained on the critical mass, edge fuel worth, inter blanket worth, control rod worth, safety rod worth, flow dependence of reactivity, pressure coefficient of reactivity, isothermal temperature coefficient, material worths in core, reactivity worth of source neutrons, absolute power calibration, core reproducibility, and safety rod drop tests. Rather good agreement with predicted values was obtained. (C.E.S.)

14814 (CONF-631201(p.27-32)) THE ENRICO FERMI FAST NEUTRON BREEDER REACTOR. PROGRAM FOR PERIOD IMMEDIATELY AHEAD. Walter J. McCarthy, Jr. (Power Reactor Development Co., Detroit).

The program for the operation and development of the Fermi Fast Reactor is outlined. Completion of the low power nuclear tests program and preparation for high power operation, step-wise increase to 200 Mw(t) operation, and operation after 200 Mw demonstration are discussed. (C.E.S.)

14815 (CONF-631201(p.36-40)) NEED FOR RESEARCH AND DEVELOPMENT PROGRAMS ON NUCLEAR POWER DEVELOPMENT. Louis H. Roddis, Jr. (Pennsylvania Electric Co., Johnstown).

Research and development in the nuclear power field is discussed, and the role of the federal government and industry in the research and development program is considered. (C.E.S.)

14816 (CONF-631201(p.46-52)) THE NEED FOR FAST REACTORS AND PLUTONIUM IN THE NUCLEAR POWER COMPLEX. John R. Dunning (Columbia Univ., New York).

Diffusion plant problems and fuel ownership, conservation of uranium and thorium, industry's responsibility to support research and development, utilization of uranium-235 and plutonium, capabilities and potential of the fast reactor, independence of diffusion plants, conservation of natural resources, economic utilization of high cost ores, utilization of both uranium and thorium, and breeding sufficient for electric power growth are discussed. (C.E.S.)

14817 (CONF-631201(p.52-8)) THE MERITS OF PLUTONIUM AS A REACTOR FUEL, THERMAL OR FAST. Walter H. Zinn (Combustion Engineering, Inc., Windsor, Conn.).

The value of plutonium in both thermal and fast neutron systems is discussed. The magnitude of the fissile material energy resource and the relation of plutonium to it are examined. The dollar value of plutonium is also briefly considered. (C.E.S.)

14818 (CONF-631201(p.58-65)) CAPABILITIES OF THE FERMI REACTOR IN ADVANCING BREEDER TECHNOLOGY AND THE USE OF PLUTONIUM FUEL. Wayne H. Jens (Atomic Power Development Associates, Inc., Detroit).

Fast reactor requirements are outlined, and the technical areas in which the Fermi Fast Reactor can play a leading role by making major contributions to the development of the economic fast breeder reactor are discussed. These areas include fuel irradiation, material irradiation, core tests, blanket testing and demonstration, component and system verification, in-core instrumentation tests, critical experiments, coolant chemistry experiments, shielding measurements, modified component tests, remote maintenance demonstrations, and operator training. (C.E.S.)

14819 (CONF-631201(p.71-5)) UNITED KINGDOM FAST REACTOR PROGRAM. William Cook (United Kingdom Atomic Energy Authority, London).

A brief review is given of the startup and operation of the Dounreay Fast Reactor, and the fuel development program is outlined. The program for obtaining physics measurements on plutonium fueled cores is also discussed. (C.E.S.)

14820 (CONF-631201(p.75-80)) UNITED STATES FAST REACTOR PROGRAM. Frank K. Pittman (Division of Reactor Development, AEC).

The fundamental research on the fast breeder reactor, including development of its fuels and their safe and economic fabrication and use are reviewed. Past, present, and future programs are outlined, and objectives, cost, and management of the programs are considered. (C.E.S.)

14821 (CONF-631201(p.80-5)) EURATOM FAST REACTOR PROGRAM. Jules Gueron (European Atomic Energy Community).

A description of the Euratom fast reactor program is presented, including the RAPSODIE program, research and development aiming at the design of future fast power reactors, physics experiment facilities, and general research and development support. (C.E.S.)

14822 (CONF-446-45) THE DESIGN OF A 1000 Mwe FAST BREEDER REACTOR. C. E. Klotz, E. A. Fischer, R. S. Miller, J. B. Nims, R. G. Palmer, and G. R. Winders (Allis-Chalmers Mfg. Co. Atomic Energy Div., Bethesda, Md.). [nd]. Contract AT(11-1)-1316. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The design characteristics of a 1000-Mwe, sodium-cooled, oxide-fueled, fast breeder reactor are summarized. Attention is given to the core configuration, fuel handling, and reactor parameters and characteristics. (T.F.H.)

14823 (CVNA-222) ANALYSIS OF ZERO POWER TEMPERATURE COEFFICIENT MEASUREMENTS FOR THE CAROLINAS VIRGINIA TUBE REACTOR. Raymond J. Nath (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Feb. 1965. Contract AT(30-1)-2289. 45p. Dep.(mn); $2.00(cy), 2(mn) OTS.

A description of the experiments performed to measure the temperature coefficients at zero power on the CVTR is presented along with the methods of analysis used and the results obtained. It was found that over the range of measurements the temperature coefficient associated with the fuel and primary coolant was essentially constant with a value of -0.4×10^{-4} °F^{-1}. The moderator temperature coefficient was measured over the range of 85 to 180°F and varied from -0.65×10^{-4} to -1.15×10^{-4} °F^{-1}. (auth)

14824 (DP-919) MEASUREMENT OF MIGRATION AREA AND ANISOTROPY IN A MOCKUP OF THE EL-4 LATTICE. Albert E. Dunklee and Warren B. Rogers (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1964. Contract AT(07-2)-1. 67p. Dep.; $3.00(cy), 2(mn) CFSTI.

Nuclear parameters of the lattice for the French power reactor, EL-4, were determined in mockup lattices. The reactor is to be D_2O moderated, gas cooled, and fueled with UO_2 rod bundles. The mockup lattice had a square lattice pitch of 23.09 cm and was fueled by 19-rod clusters of 1.27 cm diameter natural uranium rods inside air-filled 12.7-cm diameter housing tubes. Bucklings were determined for various pile shapes by measured flux profiles. Detailed studies were made of the diffusion properties of the lattice with emphasis on the anisotropic diffusion due to the neutron streaming in the air-filled channels. Such studies included determination of the axial migration area by neutron poisoning techniques as well as by observation of the neutron kinetics of the pile on stable positive periods. Ratios of axial to radial migration areas were deduced from the buckling measurements on the different shaped piles. Measurements of radial and axial diffusion coefficients were made by activation techniques and by measurements of the reactivity effect of introducing D_2O into coolant channels of selected pile positions. Agreement of the measurements with theoretical predictions was generally good. (auth)

14825 (DPST-64-83-9) USAEC–AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, SEPTEMBER 1964. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 22, 1964. Contract AT(07-2)-1. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Irradiation of a five-bundle fuel assembly in the HWCTR to assist in the development of fuel for CANDU is discussed. The assembly failed and the faulty element is being examined remotely. In other work, cooling of heavy-water-moderated reactors by light water is being investigated along with the physics behavior of burned-up fuel in CANDU. Tests are being conducted to determine the factors that control orientation of ZrH platelets in Zircaloy tubing. (J.R.D.)

14826 (EURAEC-1230) HYDRODYNAMIC INSTABILITY LIMITING THE POWER OF BOILING WATER REACTORS. Quarterly Report No. 1, January 1–March 31, 1964. (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble). Work Performed under United States–Euratom Joint Research and Development Program. Contract 006-64-1 TEEF. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The purpose of the study and the philosophy of the methods used are described. Definitions are recapitulated, different instability types are enumerated, and a division of these phenomena into two categories is proposed: "instabilities", which are not essentially periodic (these are irregular fluctuations, sharp variations in flow rate, and "chugging"; and "oscillations," which have well-defined period and amplitude. A graphic method is described to obtain the steady-state operation point of a two-phase loop. The method is based on the graphic resolution of the thermal balance and the dynamic equations. This method is shown to be suitable for the prediction of the thresholds of thirst-category instabilities. A "single-phase" model is proposed for the study of "oscillations." It is based on the "density effect," which is the specific gravity versus enthalpy variation. (auth)

14827 (GA-5411) BURNUP INDEPENDENT POWER SHAPING BY FUEL ZONING. K. R. Van Howe (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 28, 1964. Contract AT(04-3)-167. 19p. (CONF-654-35) Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Nuclear Society Meeting, San Francisco, Nov.–Dec. 1964.

The desirability of shaping the power distribution of a reactor to maximize the power output is well known. One method available for power shaping is fuel zoning. Shain and Green have presented a technique for zoning the fissile material to yield a desired initial power distribution. However, in reactors with significant conversion ratios, it is also necessary to zone the fertile material in order to maintain the initial power shape throughout large burnup periods. A procedure is presented for determining the fissile and fertile loading distribution which will yield any desired burnup independent power distribution. (auth)

14828 (GEAP-4723) SODIUM-COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 12, July–September 1964. C. E. Breizy, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1964. AT(04-3)-189. 89p. Dep.(mn); $3.00(cy), 3(mn) OTS.

Irradiation of fission product plugging capsule, B3A, was terminated when an extremely high temperature rise (>2000°F) occurred indicative of a possible fuel failure. Preliminary nondestructive examination confirmed that significant fuel redistribution had taken place. The final transient irradiation of Capsule C2C (designed for transient energy input to the point of clad deformation or penetration) was successfully run at TREAT. Preliminary examination indicates that cladding failure has occurred. Indications are that the cladding did not melt prior to failure and that failure may then be attributable to either fuel vapor pressure or restrained thermal expansion. Control sample capsule, C3D (one of the three high burnup pre-irradiated mixed oxide series), was found to have failed upon completion of its pre-irradiation. Fuel sampling and thermal ratchetting due to excessive rod power appear to be the probable causes of clad failure. Capsule E1A, designed to test the feasibility of central temperature measurement in mixed oxide fuel using both refractory metal thermocouples and gas-bulb thermometry, was completed and successfully irradiated during GETR Cycle 57. The thermocouple and the gas pressure system both functioned satisfactorily throughout the cycle. Examination of the high burnup capsule, E2B, (whose irradiation was halted at about 70,000 Mwd/Mt when temperature readings indicated an overpower condition in the fuel) revealed that the upper fuel pin and a region at the upper end of the lower fuel pin were damaged. The tentative explanation is that the bottom fuel pin (hyperstoichiometric) failed first, releasing its fission gas which rose to blanket the upper fuel pin causing its overheating. Initial examination of Capsule E3A (designed for plutonium migration study, containing eight fuel pins of varying O/M ratios, six high temperature and two low temperature) showed that the cladding on all six high-temperature pins had ruptured. It is tentatively concluded that the passage of a gas bubble through the thin clad-thermal barrier gap caused failure of the top three pins. The mode of failure of the other fuel pins is hypothesized to be one of the bottom pins, E3A-5 or E3A-6, momentarily operated at an overpower condition, failed, and released gases to progressively fail the pins above, or a small gas bubble trapped during the NaK filling operation broke loose and moved upward when the capsule was jostled. Encapsulated fuel specimens for Group 1 (four specimens for single-cycle irradiation at high power) and for Group 2 (nineteen specimens for long-term irradiation at high power) had been completed and shipped to ANL. Their radiographic and ultrasonic examinations disclosed voids within the capsules. Non-destructive treatment of these capsules was successful in reducing the major bottom end void from about $\frac{5}{8}$-inch long to $\frac{9}{32}$-inch long, but has not completely eliminated it. Using data obtained from tests of vented-to-coolant design performed under Task B (Vented Fuel Development) a technical and economic analysis of the aspects of venting fission gases to the coolant was completed. Preliminary calculations, made to evaluate the effectiveness of the flux trap concept as a means of minimizing the sodium void reactivity increment in fast reactors, indicate some related penalties. While the concept shows some promise of reducing the sodium void effect, increased power peak, reduced breeding ratio and Doppler coefficient become problems requiring further careful consideration. (auth)

14829 (HPR-40) COOLANT VOID REACTIVITY EFFECTS IN THE SECOND FUEL CHARGE OF HBWR. PART II. DIFFERENTIAL EXPERIMENTS AT HIGH TEMPERATURES. F. W. A. Habermann (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). Nov. 1964. 39p. Dep.(mn).

The reactivity effect of completely voiding the coolant channel in a single UO_2 cluster fuel element in HBWR was measured at various temperatures between 55 and 220°C. The reactivity effect was measured as a function of void depth, using the technique of depressing the D_2O level in the coolant channel by argon under pressure. The void reactivity effect is analyzed using two group perturbation theory for an anisotropic lattice. Theoretical comparisons are made applying the Swedish lattice parameter recipe Burnup 5. The theory systematically predicts a too high negative reactivity by about 10% throughout the temperature range. (auth)

14830 (HW-81602(p.4.1-8)) EBWR PLUTONIUM RECYCLE FUEL. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Fuel rods for the first EBWR core loading were completed. Processing of UO_2–1.5 wt % PuO_2 fuel is near completion. Evaluation of 474 Zircaloy-2 replacement cladding tubes revealed 55 had defects greater than 0.001 in. Capsule tests continue to indicate that the EBWR fuel rods will exhibit satisfactory performance under proposed EBWR conditions. (auth)

14831 (HW-81984(p.3.1-14)) ANALYTICAL STUDIES AND ADVANCED CONCEPTS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Fuel cycle studies were devoted to ^{242}Pu problems in successive Pu recycle, economic comparison of ^{241}Pu and ^{239}Pu as enrichment material, development of YUKON code for U conservation studies, SUPERCASE GENERATOR for

fuel cost minimization, QUICK for reactor economics, and ALTHAEA for burnup. Advanced reactor studies are reported on fast supercritical pressure power reactor, development of RAPTURE for fission capture cross sections, and development of computer codes for parametric studies. Other reported work is on sonar power systems, and High-Temperature Lattice Test Reactor. (J.R.D.)

14832 (HW-81984(p.11.1-14)) PLUTONIUM RECYCLE TEST REACTOR OPERATION AND RELATED ACTIVITIES. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Design analysis and testing work related to the PRTR are reported along with aspects of the operation. Modifications of the Plutonium Recycle Critical Facility for operation of the light-water EBWR core are discussed along with operation of the Fuel Element Rupture Testing Facility. Other work is reported on safety studies of mixed oxide fuels, PRTR power increase studies, fuel reuse studies, reactor decontamination, and PRTR fretting corrosion. Research on heavy water reactor thermal hydraulics is also reported. (J.R.D.)

14833 (IDO-10040) A SUMMARY REPORT ON ML-1 FUEL ELEMENT DEVELOPMENT IN-PILE TEST HISTORY. George L. Vivian (Idaho Operations Office, AEC). June 1964. 32p. Dep.; $2.00(cy), 1(mn) OTS.

In-pile tests on ML-1 fuel elements are summarized. Data are included on irradiations of GCRE concentric curved fuel plates, GCRE fuel pins, fuel pins used in the first and second ML-1 cores, and test capsules. (T.F.H.)

14834 (LA-3174) TRANSIENT TEMPERATURE ANALYSIS OF THE FUEL LOADER PUSH ROD AND GUIDE TUBE IN THE ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX). C. H. Treat (Los Alamos Scientific Lab., N. Mex.). Sept. 1964. Contract W-7405-eng-36. 24p. Dep.; $2.00(cy), 1(mn) CFSTI.

During the fuel loading procedure in the Ultra High Temperature Reactor Experiment (UHTREX) the fuel loader guide tube is subjected to a high thermal radiation flux. Various means by which the resultant heating of the guide tube may be minimized are examined. (auth)

14835 (NAA-SR-10153) TEMPERATURE DISTRIBUTIONS IN THE SRE CORE-II FUEL ELEMENTS. C. L. Peckinpaugh (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1965. Contract AT-11-1-GEN-8. 21p. Dep.; $1.00(cy), 1(mn) OTS.

Measurements with an experimental bowable fuel cluster showed that unusually large steady-state temperature differences existed within the SRE Core-II fuel coolant channel. Large temperature differences were measured across the rod bundle, between the inside and outside coolant regions, and across the annular outside flow area. The maximum radial ΔT observed was 200°F. The temperature difference across the rod bundle was caused by misalignment (thermal bowing) of the fuel rod cluster within the coolant channel. The ΔT between the inside and outside coolant regions was caused by an unbalance of power generation and flow rate. The ΔT across the outside coolant region occurred because of higher velocity sodium bypassing the rod bundle in the large annular clearance between the bundle and the coolant channel wall. Comparison of calculated temperature differences with measured results indicated that insufficient radial coolant mixing within the rod cluster was caused by excessive bypass coolant flow around the spiral wire wraps. Future fuel element designs may minimize these temperature differences by maintaining the fuel rod bundle concentric in the coolant channel, matching the regional power generation with flow rate, and increasing mixing by minimizing the clearance between the wire wraps and the channel wall. (auth)

14836 (NAA-SR-10721) DRILLING GRAPHITE SAMPLES FROM IRRADIATED SRE MODERATOR ELEMENTS. R. D. Phelps (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1965. Contract AT-11-1-GEN-8. 47p. Dep.; $2.00(cy), 1(mn) CFSTI.

A technique was developed to obtain samples of graphite from irradiated SRE moderator elements. Following removal of a small circular piece of cladding material from the surface of the element, a coring drill is used to cut a cylindrical graphite sample, 1 to 2 in. in diameter, extending from the surface of the graphite to the central coolant tube. The resulting graphite core is removed from the drill and stored under an inert atmosphere in a sealed container. Radiation levels associated with the graphite extracted from the element are less than one mr/hr per cubic inch after more than 6000 Mwd of exposure. The moderator element from which these samples are taken is also measured across-the-flats at 1-ft intervals over its entire length. The results are accurate to ±20 mils, which is less than the design tolerances specified at time of fabrication. A total of 26 samples was drilled from two moderator elements, one of which contained sodium-saturated graphite. Most of the equipment used during this program exists at the SRE; special tools were designed as necessary to accomplish the more intricate operations. (auth)

14837 (NOLTR-62-207) RESPONSE OF ENRICO FERMI REACTOR TO TNT SIMULATED NUCLEAR ACCIDENTS. W. R. Wise, Jr., J. F. Proctor, and L. P. Walker (Naval Ordnance Lab., White Oak, Silver Spring, Md.). Nov. 13, 1964. 167p. Dep.; $5.00(cy), 4(mn) CFSTI.

The Enrico Fermi Atomic Power Plant—world's largest fast breeder reactor—is a 65,900-kw facility currently nearing full-power operation status at Lagoona Beach, Michigan. Access to the sodium-cooled core is provided by a 143-ton shield plug. The MHA (maximum hypothetical nuclear accident) for the Fermi reactor was postulated not to exceed in violence the detonation of 1000 pounds of TNT at the core location. An attempt is made to predict the structural response of Fermi to the MHA, particularly the possible jump of the shield plug. An extensive experimental program was conducted in which scaled charges of explosives (some cased in molten sodium) were detonated in idealized models of the Fermi reactor. The results of this experimental program together with available theory indicate that the accident would be contained within the reactor shielding complex, but that the 143-ton shield plug, if unimpeded, might be propelled as high as 102 feet and through the roof of the containment building. In response to the findings of this extensive study, the Fermi reactor will be equipped with an arrester that will prevent a hazardous plug jump in the unlikely event of a nuclear accident. (auth)

14838 (PAN-543/IX) FRUSS—1000 MWe REAKTOR GRAFITOWO-GAZOWY z U_{nat} Z KANALAMI CISNIENIOWYMI NA PARAMETRY NADKRYTYCZNE. (FRUSS—1000 Mw(e) Natural U Gas-Cooled Graphite Moderated Pressurized Reactor for Supercritical Steam Parameters). Jerzy Lopuszynski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1964. 21p. Dep.

The application of pressurized channels with enriched uranium superheating supercritical steam in a U_{nat}-gas-graphite reactor is proposed. Present designs of integral type graphite-gas reactors which contain a heat exchanger, blower, and also a charge and discharge machine in a concrete pressure vessel (e.g. EDF 5) make this concept feasible. This gives a reactor with many advantages such as: high steam parameters and high power density, small number of channels and large power unit, a good fuel cycle and low capital investment, etc. The main difficulties lie in obtaining remote joining and separation of the channels from the high pressure circuit and providing for accidental bursting of a pressure tube. (auth)

14839 (SAN-8002(p.3-9)) EBR-II SYSTEM AND COMPONENT EXPERIENCE. Summary. R. A. Jaross (Argonne National Lab., Ill.).

Operation history and components performance in EBR-II are summarized. (T.F.H.)

14840 (SAN-8002(p.10-29)) HNPF OPERATING EXPERIENCE AND TESTING TO 250 MWt. J. Denny Cochran (Consumers Public Power District, [Hallam], Neb.).

A description is given of the site and physical plant at Hallam Nuclear Power Facility. Descriptions are given of the reactor startup, 100% power testing, and operational experience prior to Aug. 1, 1963. (T.F.H.)

14841 (SAN-8002(p.30-47)) ENRICO FERMI ATOMIC POWER PLANT STEAM GENERATOR EXPERIENCES. C. M. Heidel (Detroit Edison Co., Detroit).

The Enrico Fermi plant contains three steam generators, each of which is connected to an intermediate sodium-sodium heat exchanger, which is in turn connected to the primary sodium cooling system of the reactor. A description is given of the materials selection, stress corrosion, sodium compatibility, vibration testing, operation, and performance of these steam generators. Both mockup and full-scale tests are reported. (T.F.H.)

14842 (SAN-8002(p.127-50)) THE ENRICO FERMI ATOMIC POWER PLANT. Kenneth P. Johnson (Power Reactor Development Co., Detroit).

During the course of non-nuclear tests of the Enrico Fermi reactor, failures occurred which required draining the liquid sodium coolant. The repair of the holddown mechanism within the reactor vessel was accomplished by sending men dressed in protective suits into the cooled vessel. Sodium clinging to the internal parts of the reactor was protected from oxygen or water by an argon cover gas. Caustic embrittlement of the stainless steel was avoided by the cover gas and by encasing the men in the protective suits. (auth)

14843 (SRO-110) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, NOVEMBER 1964. (Savannah River Operations Office, AEC). 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Research is reported on fluid dynamics and heat transfer, Zr technology, irradiation of CANDU fuel, and fuel development. Operations of the Heavy Water Components Test Reactor and the Carolinas-Virginia Tube Reactor are summarized. (J.R.D.)

14844 (TID-21593) 237-MW KRB NUCLEAR POWER PLANT. Quarterly Report No. 5, April 1–June 30, 1964. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen, Germany). 120p. (KRB-1964/2; EUR/C/5494/64e). Dep.(mn); $4.00(cy), 2(mn) OTS.

Fabrication of the components of the power plant, including the containment shell, pressure vessel, steam generators, circulating pumps, and turbine, is continuing. With the exception of the reactor building, the construction work is well in hand. The rough work on the reprocessing building, including the 110 m high stack, was completed, the roof and crane girders put up in the turbine house, and the shuttering fitted prior to the concreting of the turbine foundation. (auth)

14845 (WAPD-BT-31(p.1-17)) AN EXPERIMENTAL CONFIRMATION OF PWR CORE 2 SEED 1 POISON WAFER SPACE DESIGN. PART I. TESTS MADE IN INITIAL POISON PLATE. PART II. TESTS MADE IN MODIFIED POISON PLATE. J. E. Sharbaugh (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Spacer rings are used in PWR Core 2 Seed 1 poison plates to maintain positioning of poison wafers, and the rings are fixed in position by depressing (dimpling) the plate cladding into the centers of the rings. To demonstrate the suitability of this design, poison plate sections were subjected to tests representing the most adverse conditions to which the plates would be exposed during reactor operation. Results indicate that the design is satisfactory and that the spacer rings will function as intended. Tests made in the initial poison plate and tests made in the modified poison plate are described. (auth)

14846 (WAPD-BT-31(p.19-25)) DEVELOPMENT OF A PROCESS FOR RECYCLING SINTERED UO_2-ZrO_2 FUEL WAFERS. T. R. O'Connell, Jr. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

During the fabrication of high density UO_2-ZrO_2 fuel wafers for PWR Core 2, Seed 1, rejects were accumulated at various post-sintering processing and inspection operations. A method was developed for recycling the rejects to produce powder from which wafers can be fabricated which are similar in all respects to those fabricated from virgin raw materials. (auth)

14847 (WAPD-BT-31(p.37-42)) APPLICATION OF DIFFUSION CALCULATIONS TO N^{16} SPECIFIC ACTIVITY. K. Shure and N. R. Williamsen (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The flux distribution of high-energy neutrons within and close to a reactor core, required for calculation of ^{16}N specific activity in pressurized water-cooled and moderated reactors, can be determined efficiently through the use of one-group diffusion procedures. Results obtained compare favorably with those from earlier methods. The diffusion procedure is readily adaptable to an arbitrary spatial fission variation in one or more dimensions. (auth)

14848 (WAPD-BT-31(p.75-85)) RELEASE AND DISTRIBUTION OF FISSION PRODUCTS FROM PWR CORE 2 FUEL MATERIALS. P. W. Frank (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The mechanisms and distribution of fission products released from small holes in the cladding of PWR Core 2 fuel plates under irradiation are discussed. It is concluded that the release of all fission products having half lives less than a few hours is controlled by recoil escape from the fuel. The release of long-lived rare gases, halides, and alkali metals is controlled by diffusion from the fuel. Equations are presented for calculating the release of fission products from PWR Core 2 fuel plates. (auth)

14849 (WAPD-LPR-181) LARGE POWER REACTOR (LPR) PROGRAM. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1963. Contract AT(11-1)-Gen-14. 112p. Dep.(mn); $4.00(cy), 3(mn) OTS.

See WAPD-LPR-256 for Suppl. to this report.

An evaluation of the feasibility of large seed-blanket reactors for application in a central-station power plant producing at least 500 Mw(e) is carried out. Stress is laid on safety, reliability, and ease of maintenance. Two design concepts are under consideration, a thorium seed-blanket converter-burner core capable of 10 yr operation between refuelings, and a thorium seed-blanket converter-recycle core having high breeding potential for refueling at 3 to 4 yr intervals. The latter core is cooled and moderated with water. Reactor compatibility with the power plant is also considered. Power costs and fuel-cycle cost are evaluated. (T.F.H.)

14850 (WAPD-LPR-256) LARGE POWER REACTOR (LPR) PROGRAM. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1964. Contract AT(11-1)-Gen-14. 73p. Dep.(mn); $3.00(cy), 2(mn) OTS.

See also WAPD-LPR-181.

An evaluation of the feasibility of large seed-blanket reactors for application in a central station power plant producing at least 500 Mw(e) is carried out. Stress is laid on safety, reliability, and ease of maintenance. Two design concepts are under consideration, a thorium seed-blanket converter-burner core capable of 10 yr operation between refuelings, and a thorium seed-blanket converter-recycle core having high breeding potential for refueling at 3 to 4 yr intervals. Reactor compatibility with the power plant is also considered. (T.F.H.)

14851 (WCAP-2703) 1000-MWe SUPERCRITICAL PRESSURE NUCLEAR REACTOR PLANT STUDY. Quarterly Progress Report No. 11, July 1–September 30, 1964. H. B. Kellogg, comp. and ed. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Nov. 1964. Contract AT(30-1)-2948. 50p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The completion of 568 hours of supercritical pressure and temperature testing with three 16 Cr–20 Ni stainless collapsed clad corrosion test specimens in the out-of-pile loop is reported. (auth)

14852 (ORNL-tr-402) DEVELOPMENT OF NUCLEAR POWER ELECTRICAL POWER PLANTS IN LENI

WORKS IN PILSEN. J. Hauer. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 1-5(1964). 19p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The design activities involved in the development of the first Czechoslovak nuclear power plant are reviewed. (T.F.H.)

14853 (ORNL-tr-403) PERSPECTIVES ON NUCLEAR ELECTRICAL POWER PLANTS IN CZECHOSLOVAKIA. Vaclav Chlumsky and Arnost Komauk. Translated for Oak Ridge National Lab., Tenn., from Tech. Zpravodaj, 1: 6-9 (1964). 11p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The first Czechoslovak power reactor is a 150-Mw(e), natural-U, gas-cooled, pressure-vessel reactor. A description is given of its core, its circuits, and its purposes. The relative merits of conventional and nuclear power plants are discussed. (T.F.H.)

14854 THE STATE OF DEVELOPMENT OF THORIUM BREEDERS. R. Schulten (Kernforschungsanlage, Julich, Ger.). Atomwirtschaft, 10: 23-4(Jan. 1965). (In German)

A research program is being carried out on a thermal reactor using the thorium–uranium cycle and based on the spherical-mass high-temperature reactor. Analysis of the economics indicated that the smaller breeding rate will be at least compensated for by the high specific loading, i.e., the lower charge of fissionable material. The development of thorium breeders is based on an existing technology, which probably will be tested during the next few years. Prototype reactors of the types in question, namely D_2O molten-salt and high-temperature reactors, are on the verge of completion. In the case of high-temperature thorium breeders using coated particles in graphite spheres, fuel utilizations of up to 60,000 MWd/t, operating temperatures of up to 1,400°C and specific loadings of 5 to 6 g/kw(e) are expected. At a thermal efficiency of 90% these figures indicate a specific fuel charge of 0.5 g/kw(e) (compared with 4 to 6 g/kw(e) for present reactors). On the basis of present ideas and the available data a doubling time of 10 years or less is expected with thermal breeder systems. (auth)

14855 CONSIDERATIONS ON THE INSTRUMENTATION IN THE CORE OF THE ORGANIC REACTOR AND ON THE SUCCESSIVE ELABORATION OF THE DATA. Franco Cesari. Ing. Nucl., 5: No. 5, 9-31(Sept.-Oct. 1964). (In Italian)

The instrumentation of the first core of the P.R.O. Reactor is both protective and investigative. It signals abnormal conditions in the reactor behavior, measures the effective operating conditions of the core, and compares the actual behavior (neutron and thermal) with the predicted behavior. The instrumentation consists of: system for detecting the space distribution of the neutron flux; circuit for the detection and localization of damaged fuel elements; system for the measurement of the difference in temperature of the fluid at inlet and output at all fuel elements; some elements of fuel instrumentation; and experimental circuits for testing fuel elements and organic fluids. The data is fed to a computer which processes the information for the operator. Some considerations on the type of instrumentation and the selection of the site best suited for its installation are presented. (tr-auth)

14856 A METHOD OF PARAMETER OPTIMALIZATION FOR A HEAVY WATER GAS-COOLED NUCLEAR POWER STATION. Ladislav Bohal, Milos Drahny, Rostislav Havlicek, and Karel Januska. Jaderna Energie, 10: 434-8(Dec. 1964). (In Czech.)

The problem of complex optimization of parameters of nuclear power stations with heavy water gas-cooled reactors is discussed, namely from the point of view of the method. A mathematic model of technologic and economic processes was formed and on the base of consistent criteria of the optimum the choice of the optimum variant was made. Some modern methods of the evaluation of these problems using automatic digital computers are suggested as well, and some results are reported in the form of graphs. The investigation represents a methodic contribution to the problem of complex optimization, and after some modifications it may be applied in broader range of power engineering than in just the nuclear branch. (auth)

14857 CONTINUOUS PURIFICATION OF WATER-COOLED POWER REACTOR PRIMARY COOLANT CIRCUIT BY ION EXCHANGE. R. Winkler and A. Schoenherr (VEB Atomkraftwerk, Betriebsteil Rheinsberg/Mark, Ger.). Kernenergie, 7: 741-8(Nov. 1964). (In German)

A comprehensive report on the problem and methods of purification of the primary circulation in ion exchangers is presented. The origin of impurities and their harmful effect are discussed in general terms and on the basis of specific examples. Next the chemical and technical aspects of ion exchange are considered with emphasis on impurities whose major parameters are the pH-value and the sizes of crude particles. A discussion follows of mechanical filter design and performance, and treatment of the ion exchanger. Some data are given on operating temperatures and pressures. Forty four references are listed. (OTS)

14858 THE AEROSOL ACTIVITY OF THE AIR OF THE REACTOR BUILDING AT VERSUCHSATOMKRAFTWERK KAHL. G. Knoerzer (Versuchsatomkraftwerk, Kahl am Main, Ger.). Kerntechnik, 7: 22-5(Jan. 1965). (In German)

Already small leakages in the primary loop are able to increase the aerosol activity of the air in the reactor building considerably. Reported are measurements which are necessary to watch over and to determine the composition of this activity. The activity concentrations of primary water, of steam, and of the air of the reactor building are compared. (auth)

14859 SUBROUTINES OF POWER REACTOR TRANSFER FUNCTION (SPORT). [Y. Yoshinaka]. Meidensha Jiho, 47: 44-52(Apr. 1963). (In Japanese)

14860 CANADIAN REACTOR SHIELDING. A. C. Whittier (Canadian General Electric Co., Peterborough, Ont.). p.3-13 of STI/DOC/10/34.

The shielding design and characteristics for NPD reactor are surveyed. NPD is a 22-Mwe heavy-water-cooled and -moderated reactor. (T.F.H.)

14861 STUDY ON THE POTENTIALITIES OF THE USE OF A NUCLEAR REACTOR FOR THE INDUSTRIALIZATION OF SOUTHERN TUNISIA. Technical Reports Series No. 35. (International Atomic Energy Agency, Vienna). 1964. 33p. $1.00; S21,-; 6/-stg; F.Fr.4,-; DM3,20 (IAEA). STI/DOC/10/35

A preliminary study was made of the possible use of a nuclear dual-purpose installation for the production of both electric power and desalted water. The factors likely to have a bearing on the features of the plant are discussed. It is concluded that the minimum capacity of the largest generating unit for the network is 51-58 Mw, and that the water demand will vary between 12,000 and 22,000 m^3/day. Power and distilled water costs figure to be 3.5 millimes (8.5 US mills)/kwh and 45-77 millimes/m^3 ($0.40-0.70/1000 gal), respectively. (D.L.C.)

14862 THE IMPACT OF NUCLEAR POWER ON THE COMMUNITY. R. O. Brittan. 13p. (CONF-714-4)

From Conference on Nuclear Education in the New Era of Nuclear Power, Gatlinburg, Tenn., Aug. 1964.

Several random effects of nuclear power on the public are described. The techniques used by small pressure groups to block the location and construction of nuclear power plants are discussed in some detail, with Ravenswood and Bodega Bay as recent examples. Some of the educational tools which the nuclear power industry can use to counter these groups and to improve communication with the public are described. (D.L.C.)

14863 NUCLEAR REACTOR PLANT FOR UTILIZING HEAT GENERATED THEREIN. Jakob Kaegi (to Sulzer Freres). U. S. Patent 3,161,572. Dec. 15, 1964. Priority date Apr. 11, 1960, Switzerland.

In the system described for utilizing the heat generated within a nuclear reactor, conduit means conducting a fluid and forming at least two separate circuits are placed in the reactor for absorbing heat. The second circuit includes a turbine, a condenser, and an evaporator placed outside the

reactor. The fluid circulating in the first circuit serves merely for evaporating the fluid of the second circuit; therefore the first circuit can operate at a lower temperature and pressure than the second circuit. Means are provided for purifying the fluids, preferably water and steam, circulating in both circuits. (A.G.W.)

Production Reactors

14864 (DPSPU-63-30-39) QUALITY CONTROL OF MODERATOR IN SAVANNAH RIVER PLANT REACTORS. G. N. Flannagan and R. F. Anderson (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Jan. 1964. Contract AT(07-2)-1. 8p. (CONF-179-17). Dep. (mn); $1.00(cy), 1(mn) OTS.

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

The quality of moderator has been controlled quite successfully. Substantial improvements in reactor operation have been effected by controlling the moderator acidity with nitric acid. The improvements resulted in lower aluminum corrosion rate, better fuel integrity, and lower radiation exposure to personnel working close to piping and equipment containing moderator during reactor shutdown. (auth)

14865 (HW-84214) OBSERVATIONS CONCERNING NPR FLOW RESTRICTORS. D. H. White (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 25, 1964. Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Previous tests on the NPR flow restrictor, which has a throat shape consisting of two circular segments, have established that high, unrecoverable pressure losses exist. During a study of flow visualization, a number of observations concerning the flow restrictor were noted. These included separation at the throat and possible corner effects, both of which would reduce the effective throat area. The existence of circular eddies is noted along with "edge flow" in the clearance space between the channel and restrictor. The effects of these are not presently known. Two modifications to the present restrictor and a new design are suggested for consideration by future investigators. There are strong indications that major modifications or redesign are required to produce a workable NPR restrictor. (auth)

14866 (RL-SA-17A) OPERATIONAL PROCEDURES IN DEACTIVATION OF THE HANFORD PRODUCTION REACTORS. Sterling L. Nelson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 8, 1965. Contract AT(45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Procedures for the deactivation of the Hanford Production Reactors are outlined. A smooth and rapid transition from operational to non-operational status was achieved without difficulty and with a minimum expenditure of funds. A brief discussion of the more important problems and the solutions reached is presented. Radiation protection, spread of loose contamination, cooling requirements, preservation of equipment, surveillance, waste disposal, and radiation zone control are discussed. (C.E.S.)

Propulsion and Space

14867 (FZK-170-2) NERVA COMPONENTS IRRADIATION PROGRAM. VOLUME 2. ASTR TEST 1. R. D. Crabtree and F. H. Johnson (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Dec. 9, 1963. Contract AF33(657)-7201. 147p.

Several mechanical components proposed for use in the NERVA engine were subjected to radiation from the Aerospace Systems Test Reactor at the Nuclear Aerospace Research Facility. They consisted of a tank shutoff valve (TSOV), a turbine power control valve (TPCV), turbine pump assembly (TPA) bearing sets, and a static flange seal assembly (SFSA). All components were dynamically operated during the test; liquid-hydrogen flow was maintained in the TSOV, the TPA bearing sets, and the SFSA, and gaseous-hydrogen flow in the TPCV. The irradiation was for a period of 327 sec at 10 Mw. The bearing test was stopped after 155 sec because of an indication that the bearing races were overheating. (auth)

14868 (FZK-170-4) NERVA COMPONENTS IRRADIATION PROGRAM. VOLUME 4. GTR TEST 7A. (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Nov. 20, 1963. Contract AF33(657)-7201. 219p.

The third in the series of irradiation tests using the Ground Test Reactor to determine the effects of reactor radiation on candidate NERVA engine components was performed 21 through 26 August 1963. The test items included control drum actuator components, accelerometers, resistance thermometers, linear motion displacement transducers, thermocouples and connectors, strain gages, and pressure transducers—all of which were placed in dewars and submerged in liquid nitrogen during the irradiation. Two coaxial cables mounted in a container that served as a dummy fuel element were irradiated in the reactor core. These cables were cooled by a flow of nitrogen gas through the container. One cable and several H-Film samples were attached to the outside of the dewar at the north irradiation position and were irradiated at ambient temperature. (auth)

14869 (FZK-170-5) NERVA COMPONENTS IRRADIATION PROGRAM. VOLUME 5. ASTR TEST 2. W. M. Laney and J. D. Stanley (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Dec. 17, 1963. Contract AF33(657)-7201. 104p.

Several mechanical components proposed for use in the NERVA engine were subjected to radiation from the Aerospace Systems Test Reactor. They consisted of three bearings to be used in a turbine pump assembly. The bearings were installed in a tester which was dynamically operated for 300 seconds at 24,000 rpm while liquid hydrogen flowed through the tester. Reactor power was 10 Mw. The tester was exposed to integrated neutron fluxes ranging from 1.3×10^{12} to 5.2×10^{13} n/cm^2 (E > 2.9 Mev) and gamma doses ranging from 5×10^6 to 1.6×10^8 ergs/gm(C). The tester performed satisfactorily during the irradiation, and no external damage was discernible. (auth)

14870 (FZK-170-6) NERVA COMPONENTS IRRADIATION PROGRAM. VOLUME 6. ASTR TEST 3. J. W. Guinn and C. G. Pou (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Dec. 20, 1963. Contract AF33(657)-7201. 90p.

Several mechanical components proposed for use in the NERVA engine were subjected to radiation from the Aerospace Systems Test Reactor. They consisted of three bearings to be used in a turbine pump assembly. The bearings were installed in a tester which was dynamically operated for 10 minutes at 24,000 rpm while liquid-hydrogen flowed through the tester. Reactor power was 10 Mw. The tester was exposed to integrated neutron fluxes ranging from 1.9×10^{12} to 9.3×10^{13} n/cm^2 (E > 2.9 Mev) and gamma doses ranging from 5.8×10^6 to 1.1×10^8 ergs/gm(C). The tester performed satisfactorily during the irradiation, and no external damage was discernible. (auth)

14871 (FZK-170-7) NERVA COMPONENTS IRRADIATION PROGRAM. VOLUME 7. GTR TEST 9. E. E. Chappell, J. S. Kunselman, and A. R. Green (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Dec. 30, 1963. Contract AF33(657)-7201. 138p.

Various electrical components proposed for use in the NERVA engine were subjected to radiation from the Ground Test Reactor. They consisted of resistance thermometer devices, linear motion displacement transducers, strain gages, accelerometers and pressure transducers, and control drum actuator components. All components were

tested in an environment comprising nuclear radiation and cryotemperatures, with the environment for the accelerometers and pressure transducers including, in addition, mechanical vibration. The test was performed in two parts: In the first, data were taken periodically; in the second, data were taken first at power level steps of 0.01, 0.1, 1.0, and 3.0 Mw and then periodically during an extended period of 3.0 Mw. (auth)

14872 (FZK-170-8) NERVA COMPONENTS IRRADIATION PROGRAM. VOLUME 8: GTR TEST 10. J. W. Evans, W. D. McMillan, Jr., and M. B. Walton (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Dec. 30, 1963. Contract AF33(657)-7201. 162p.

The fifth in the series of irradiation tests that utilized the Ground Test Reactor to determine the effects of reactor radiation on candidate NERVA engine components was performed 24 through 29 October 1963. The test items included pressure transducers, accelerometers, system amplifiers, and a turbine power control valve (TPCV) actuator. The reactor was operated at 3 Mw for a period of 100 hours. The TPCV actuator had been previously irradiated during GTR Test 8 at 3 Mw for a period of 50 hours. The tests were conducted under ambient temperature conditions except for the pressure transducers, which were temperature-cycled periodically from ambient to ~375°F. (auth)

14873 (GEAP-3246(Rev.2)) NUCLEAR REACTOR FUEL AND CORE DATA SHEET. N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. S. G. Sawochka, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 10, 1960. Contract AT(04-3)-189. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Core II data for the G.E. N. S. Savannah Reactor are tabulated, including data on the core assembly, fuel elements and rods, neutron sources, control rods, nuclear data, and heat transfer and fluid flow. (T.F.H.)

14874 (GEAP-3446) N. S. SAVANNAH FUEL DESIGN AND DEVELOPMENT PROGRAM. REFUELING TESTS. PART II. C. M. Shields (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Mar. 23, 1960. Contract AT(04-3)-189. 54p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Tests are reported of the compatibilities of the major subassemblies of the N. S. Savannah Core II fuel assembly. These subassemblies include the production core structure, two different types of dummy prototype fuel assemblies, and the refueling equipment. (T.F.H.)

14875 (GNE/Phys/64-16) NUCLEAR ANALYSIS OF GASEOUS CORE REACTORS USING AN APPROXIMATE MULTI-GROUP TRANSPORT THEORY TECHNIQUE (thesis). Brian G. Stephan (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1964. 139p. (AD-603683). $4.00(OTS).

The results of a one-group transport theory analysis, which employs a technique for estimating the epithermal fission yields, are compared to a more rigorous fourteen-group transport theory analysis of a gaseous-core reactor. The model used for this study is a spherical gaseous-core reactor, homogeneously fueled with ^{235}U and moderated by graphite at 4000°K. (auth)

14876 (HW-78756) NUCLEAR PARAMETER SURVEY FOR SOME COMPACT, FAST-SPECTRUM, CERMET REACTORS. L. L. Maas and P. L. Hofmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 20, 1963. Contract AT(45-1)-1350. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A series of S_4 transport calculations have been carried out for a variety of Be-reflected cermet reactors, using idealized models in which the reactor is assumed to consist only of fuel, diluent, and voids. UO_2–W, PuO_2–W, and PuN–W cermets are considered as fuels, with W contents of 0 to 50 vol %. The results give an estimate of the relative reactor weight and volume for these fuels, for use in nuclear-rocket calculations. (T.F.H.)

14877 (NAA-SR-9781) SNAP AEROSPACE SAFETY PROGRAM, PHASE I WIND TUNNEL TESTS. L. E. Shpiner and H. Hidalgo (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1, 1965. Contract AT-11-1-GEN-8. 54p. Dep.; $3.00(cy) 1(mn) CFSTI.

The operation, parameter selection, and thermopaint technique are described for a series of tests conducted in a hotshot wind tunnel. These tests were performed to determine the distribution of aerodynamic heating intensities on the surfaces of the SNAP 10A reactor during orbital reentry. (auth)

14878 (RTD-TDR-63-3003) REENTRY AND DISPOSAL PHENOMENA FOR NUCLEAR AUXILIARY POWER SYSTEMS. Final Report. (General Dynamics/Astronautics, San Diego, Calif.). Nov. 1963. Contract AF29-(601)-4893. 293p. (AD-424400). $19.75(OTS).

Several phenomena associated with the reentry from orbit of a satellite-borne nuclear power source and the subsequent dispersal of radioactive debris are examined. The obvious hazards to the civilian population in the dispersal areas motivated this study. The immediate purposes of the study were to establish the possibility that reentry through the atmosphere would cause the nuclear fuel elements to incinerate and thereby to be rendered innocuous. Although a large volume of data in many parameters was derived from this study, no definitive conclusions can be made, but it is generally indicated that incineration alone is not a sufficient guarantee that the hazards of radioactive fuel deposition on earth were eliminated. (auth)

14879 (JPRS-28656) THE INSTALLATION AND TESTING OF MARINE NUCLEAR PLANTS. L. P. Zuev and E. (Ye.) N. Malakhov. Translated from p.83-91 of "Slesar'-Montazhnik Sudovykh Parovykh Kotlov i Teploobmennykh Apparatov," Leningrad, 1964. 10p. (TT-65-30288). $1.00(OTS).

Radiation monitoring and safety activities during the installation and testing of nuclear power plants in ships are discussed briefly. (C.H.)

14880 ROMASHKA IN PERSPECTIVE. Sheldon D. Strauss. Nucleonics, 22: No. 12, 68-70(Dec. 1964).

Romashka is a Soviet-developed thermoelectric direct-conversion reactor, intended for space applications. The design features and performance of Romashka and SNAP 10A are discussed and compared. (M.J.T.)

Research and Test Reactors

Refer also to abstract 13859.

14881 (CRRP-1209) THE CALCULATION OF POWER DISTRIBUTIONS AND REACTIVITY IN THE CONVERTED NRU. E. Critoph (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1964. 58p. (AECL-2139) Dep.; $1.50(AECL)

The demands being made on research reactors such as NRU are becoming more severe. In order to meet these demands better methods of calculation than were used in the past are required. Fortunately these methods are becoming available, and currently the two-group, two-dimensional code HEX is being used fairly extensively. The results from HEX are compared with measurements made during the startup and early operation of the converted NRU. A detailed description of the input to HEX is also given. The comparison shows that there is about a 3% discrepancy in reactivity between the calculations and the measurements. It is shown that it is very improbable that this discrepancy is associated with the HEX method of calculation itself, but must be attributed to the input. When an arbitrary adjustment is made in the input subsequent reactivity estimates are of satisfactory accuracy. The measurements of site powers in NRU are not accurate enough to adequately check the power distributions obtained from HEX. However it is felt that the evidence is strong

enough to warrant considerable confidence being placed in the estimates of changes in power distributions due to changes in loading. (auth)

14882 (FZK-185) NARF FACILITIES HANDBOOK. (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Mar. 1964. Contract 33(657)-7201. 162p.

This handbook gives an inventory of the capability of the facility, which includes the Ground Test Reactor, Aerospace Systems Test Reactor, and Reactivity Test Assembly as well as supporting facilities. The nuclear-instrumentation and irradiated-materials laboratories are discussed, and various equipment, devices, and services are described. (D.L.C.)

14383 (HW-81602(p.5.1-16)) PRTR FUEL ELEMENT FABRICATION AND PERFORMANCE. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Improvement in production time for both Vipac and swage fuel rods was accomplished by more efficient rod loading techniques. Routine underwater examination of PRTR fuel elements reveals that their general condition continues to be excellent. A short core 19-rod cluster was fabricated and is being tested in the EDEL-1 loop to evaluate possible fretting problems. Thin wall, Zircaloy-2 clad, concentric tube-in-tube fuel elements were fabricated by vibrational compaction of high density UO_2 powders. The fuel tubes were autoclaved in high pressure steam. Continued failure by a gas phase hydriding mechanism in the modified end cap region of rods containing contaminated fuel material substantiates that crevices were not the cause of previous fuel element failures. The hydriding apparatus was modified and several test capsules were hydrided. Exposure of a full length swaged UO_2 fuel rod contaminated with 165 mg I_2 has reached 4 wk at 400°C with no failures or unusual effects. The first irradiated rod was prepared and shipped for wash-out testing in the IRP loop. The full-length Zircaloy-clad Mark IX-B UO_2 inverted cluster fuel element has successfully completed its irradiation in the PRTR Rupture Loop facility. Investigations were initiated to develop underwater welding equipment. Both the efficiency and capacity of the glove box dry air supply system were improved. (auth)

14884 (HW-82372) PRELIMINARY SAFEGUARDS ANALYSIS. HIGH TEMPERATURE LATTICE TEST REACTOR. W. W. Brown, R. E. Heineman, and H. L. Henry (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1, 1964. Contract AT(45-1)-1350. 89p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The characteristics of HTLTR are outlined, and the schedule of physics measurements to be made on the core is noted. Safety studies carried out for the reactor are discussed. Safeguards inherent in the reactor design are studied. (T.F.H.)

14885 (IDO-17055) SPERT PROJECT. Quarterly Technical Report, July–September 1964. J. G. Crocker, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 1965. Contract AT(10-1)-205. 46p. Dep.; $2.00(OTS).

As part of a long-range program of in-pile kinetic subassembly tests, a series of static measurements was made with the Capsule Driver Core (CDC) in the Spert I facility. These tests included measurements of control and transient rod worths, temperature and void coefficients, fuel rod worths, neutron flux distributions, and the reduced prompt neutron lifetime. It was concluded that the operational loading of the CDC is adequate for the performance of the proposed program of in-pile kinetic subassembly tests. Measurements of the importance of voids in the upper reflector of the Spert II close-packed, D_2O-moderated core were performed using air-filled aluminum cans positioned above selected fuel positions. Calculations were performed of the reactivity compensated by fuel plate expansion and moderator heating during nonboiling power excursion tests with the close-packed D_2O core. Comparison of the results of these calculations with the results from an analysis of the power burst shape, using the conventional lumped-parameter kinetic equations, indicates that, at the time of peak power, approximately 80% of the compensated reactivity required by the solution of the kinetic equations can be accounted for by the postulated mechanisms. To aid in the analysis of the power excursion tests with the Spert II close-packed core, flow measurements were performed. These tests showed that certain methods of pump operation can result in erroneous indications of flow through the core. The spatial distribution of flow through the core was found to be essentially flat, however, regardless of the mode of pump operation. Power excursion tests with the Spert plate-type core have shown that increases in the forced flow rate produce a different effect on tests initiated at high system temperatures than on tests initiated at ambient temperature. Since an increase in flow increases the energy transfer rate to the moderator, the peak powers decrease with increasing flow rate for the tests initiated at 600°F. One of the problems in the Spert III experimental program was the acquisition of accurate fuel plate surface temperature data. Using a transfer function approach, a technique was developed whereby fuel plate surface temperatures obtained from 0.5-mil Chromel-Alumel thermocouples can be accurately reproduced by correcting data from slower-response, 5-mil Chromel-Alumel thermocouples. A program of transient tests was initiated with the Spert III plate-type core in which the excursions are performed with the reactor initially critical at power levels up to 30 Mw under system conditions of 500°F, 2500-psig pressure, and 20,000-gpm flow. Thus far, reactivity additions of 0.7 dollar were made from initial power levels of 10 and 100 kw, and 1.0-dollar insertions were made at power levels of 10, 100, and 1000 kw. Preliminary analysis of these tests has shown that the general behavior of both the reactor power and temperature was accurately calculated using the ART-04 computer code. Calculations, were made to determine the thermal stresses to which the Spert III core barrel, thermal shields, and reactor vessel wall will be subjected with the forthcoming Spert III low-enrichment oxide core operating at 60 Mw at a system temperature of 550°F. On the basis of these calculations, it was concluded that the stresses to which these components will be subjected are negligible for this operating condition. In stability tests with the Spert IV plate-type core, reactivity insertions of up to 5 dollars were made with both 2- and 18-foot hydrostatic heads above the core. In these tests, the reactor power did not become unstable as long as the inlet water temperature to the core remained near ambient. Analysis was completed of the first four tests in the TREAT reactor on PBF prototype fuel rods. Fuel rods consist of UO_2 fuel pellets surrounded by an insulating layer of ZrO_2 with a cladding of stainless steel. During these tests, the fuel pellets and insulators were cracked and/or broken. It was decided to discontinue testing of the fuel rods having coated pellets and concentrate further testing on rods using the sleeved insulators. (auth)

14886 (KAPL-M-6430) OSCAR—A PILE OSCILLATOR DATA REDUCTION PROGRAM FOR THE PHILCO 2000 DIGITAL COMPUTER. J. N. Brazos, B. A. Gottschalk, and A. L. Liedel (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 30, 1964. Contract W-31-109-eng-52. 57p. Dep.(mn); $3.00(cy), 2(mn) OTS.

OSCAR computes flux amplitudes and cross sections for samples run in a pile oscillator. The experimental technique is sensitive to very small reactivity oscillations and is hence useful in measuring enriched isotopes available in limited amounts, highly radioactive materials including spent fuel material whose handling is necessarily limited to very small quantities, materials of very small cross sections, etc. Routine work previously done by static methods may be greatly speeded. Data are accumulated on a multichannel time analyzer and transferred to punched cards for computer processing. All results are stored on magnetic tape to facilitate the application of supplementary calculations. The program running time for each case is about .5 minutes. (auth)

14887 (ORNL-TM-728) MSRE DESIGN AND OPERATIONS REPORT. PART I. DESCRIPTION OF REACTOR

DESIGN. R. C. Robertson (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 561p. Dep. (mn); $8.61(cy), 11(mn) OTS.

The design of the MSRE general layout, site, plant, fuel-circulating systems, fuel-drain-tank systems, sampler-enricher systems, coolant-salt-circulating systems, coolant-salt-storage systems, cover-gas systems, leak-detection systems, off-gas-disposal systems, containment-ventilation systems, liquid-waste systems, cooling-water systems, component-cooling systems, containment, biological shielding, and electrical and building services are reported. (T,F.H.)

14888 LOADING AND UNLOADING OF FUEL ELEMENTS AT FRJ-2 (DIDO). D. Nutbohm (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 6: 495-9(Nov. 1964). (In German)

The changing of fuel elements on the German DIDO Reactor FRJ-2 comprises three separate handling cycles. The description of each cycle starts with a short summary of handling procedure, followed by a more detailed description of the needed equipment. (auth)

14889 INTERCHANGE APPARATUS AND PROCEEDINGS AT THE ASTRA REACTOR. M. J. Higatsberger (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Seibersdorf, Austria). Kerntechnik, 6: 500-3(Nov. 1964). (In German)

The description of the changing and handling equipment in use at the Astra Research and Test Reactor is given. In particular, experiences on the changing of fuel elements, the introduction and extraction of reactor experiments and irradiation goods as well as the handling procedures for setting up detector, recording and shielding units are considered. A beam-hole changing machine developed at the Reactor Center Seibersdorf and the conception of two hot cells directly attached to the reactor tank are elaborated in detail. (auth)

14890 CHARGING MACHINE FOR HORIZONTAL EXPERIMENTAL CANALS AT THE REACTOR FRJ-2. L. Hiesinger (AEG-Kernenergieanlagen, Frankfurt am Main), M. Schulze, and G. Schwidder. Kerntechnik, 6: 503-7(Nov. 1964). (In German)

The loading and unloading of high radioactive experiments into horizontal facilities of high flux reactors have seldom been carried out needing moreover a sufficient cooling time following a reactor shutdown. A horizontal charging flask (H-flask) was designed and constructed for frequent use on the FRJ-2 Reactor. A summary description of this equipment is given. (auth)

14891 INSTRUMENTATED IRRADIATION CAPSULES AND THEIR HANDLING AT THE GEESTHACHT REACTOR STATION. J. Ahlf (Gesellschaft fur Kernenergieversertung in Schiffbau und Schiffahrt mbH, Ger.), E. Fischer, H. Richter, and W. Spalthoff. Kerntechnik, 6: 512-15(Nov. 1964). (In German)

Remarks on some general aspects regarding the design and handling of irradiation capsules are given, and two types of reloadable rigs usable to 400°C and 20 atm and one type of an autoclave-rig for single use at 400°C and 100 atm are described. Furthermore a description of operation and handling of these devices is given. A special safety problem is discussed arising in connection with these experiments, concerning irradiation of water at elevated temperatures in closed vessels. (auth)

14892 RIG IRRADIATION OF STEEL SAMPLES. D. Pachur (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 6: 515-18(Nov. 1964). (In German)

Equipment and procedures used in irradiations in the FRJ-2 reactor are shown and discussed. (D.E.B.)

14893 DEVICE FOR TRAPPING ACTIVE GASES ON THE SURFACE OF A SWIMMING POOL REACTOR. Paul Gaches (to Commissariat à l'Énergie Atomique). British Patent 976,463. Nov. 25, 1964. Priority date Nov. 28, 1962, France.

A device for trapping active gases liberated from the surface of a swimming pool reactor and for conducting these gases to devices for storing, filtering, and discharging them to the atmosphere is described. The device includes a partially immersed substantially conical deflector having its apex submerged in the cooling water, an annular collector casing disposed around the periphery of the reactor, and suction means to suck air and active gases into the casing through apertures slightly above the free level of the water in the pool. The conical deflector is centered in the reactor pool by detachable tie rods. A blower unit supported by the cone creates a centrifugal current of air parallel to the water plane. This current entrains the active gases, and they are sucked into the peripheral casing. Lighting windows may be provided in the submerged face of the shield, and the upper portion of the shield may be used for certain servicing operations. (A.G.W.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 13538, 13671, and 14117.

14894 (SAN-413-2) RADIOACTIVE WASTE-DISPOSAL POTENTIALS IN SELECTED GEOLOGIC BASINS — A RECONNAISSANCE STUDY. (American Assn. of Petroleum Geologists, Inc., Midland, Tex.). June 26, 1964. Contract AT(04-3)-413. 44p. Dep.; $2.00(cy), 1(mn) CFSTI.

The advantages of deep permeable formations for the storage of large volumes of low-level wastes from a fuel reprocessing plant, are pointed out. Descriptions are presented of the subsurface geology and hydrology of six basin provinces for the preliminary evaluation of their use for waste storage. The basins studied include the Appalachian Valley-and-Ridge Province, Michigan, Salina, Denver, and San Juan Basins. (D.L.C.)

GENERAL AND MISCELLANEOUS

14895 (BNL-869) SUBUNIT STRUCTURE OF PROTEINS. BIOCHEMICAL AND GENETIC ASPECTS. Report of Symposium held June 1-3, 1964. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 269p. (CONF-640613). Dep.; $2.75(cy), 5(mn) OTS.

Brookhaven Symposia in Biology No. 17.

Fifteen papers are presented which cover genetic and biochemical aspects of the subunit structure of proteins. The papers are arranged into six sessions dealing with interallelic complementation, enzymatic aspects of subunit association, isozymes and subunit interaction, subunits in blood proteins, and metabolic control. (D.L.C.)

14896 (BNL-896) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 2, No. 5. (Brookhaven National Lab., Upton, N. Y.). Oct. 1964. Contract AT-30-2-GEN-16. 43p. Dep.; $3.00(OTS).

Brief reviews are presented of 21 current topical and progress reports as part of various research and development programs on high-temperature liquid-metal technology. Among the topics covered are materials development, corrosion, fuels, heat transfer, fluid mechanics, boiling, chemical analysis, component development, etc. Subject and corporate author indexes are given. (D.L.C.)

14897 (BNL-7803) THE CHEMISTRY OF PEPTIDES AND PROTEINS. C. H. W. Hirs (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 105p. Dep.(mn); $4.00(cy), 2(mn) OTS.

A review is presented of the results of chemical studies of the covalent structure of peptides and proteins. (D.L.C.)

14898 (BNL-7850) A PRIORI ESTIMATE FOR CONTINUATION OF THE SOLUTION OF THE HEAT EQUATION IN THE SPACE VARIABLE. J. R. Cannon (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

It is shown that if a global bound on the u(x,t) temperature for a conductor is known, an error estimate between u(x,t) and an approximation continuation function v(x,t) can be obtained for the remainder of the conductor outside of D^*. A method is given for determining such a v(x,t). (D.C.L.)

14899 (BNL-7909) GENETIC MAP OF SALMONELLA TYPHIMURIUM. Kenneth E. Sanderson and M. Demerec (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A genetic map of Salmonella typhimurium is presented. (C.H.)

14900 (BNL-7936) A DIGITAL PROCEDURE FOR THE COMPUTATION OF AMINO ACID ANALYZER DATA. A. Yonda, D. L. Filmer, H. Pate, N. Alonzo, and C. H. W. Hirs (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A point-by-point summation procedure using a digital computer is described which was developed for the automatic computation of the peak area data from amino acid analyzers. (D.L.C.)

14901 (BNL-7942) CHROMATOGRAPHY OF TRYPTOPHAN METABOLITES. L. V. Hankes and M. Schmaeler (Brookhaven National Lab., Upton, N. Y.). [Mar. 27, 1964]. Contract AT(30-2)-Gen-16. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Paper chromatography systems are described for use in the separation of tryptophan metabolism products in urine. Some relationships between Rf value, solvent system, and structure are discussed. (C.H.)

14902 (BNL-7944) INHIBITION BY INSULIN OF HEPATIC GLUCOSE PRODUCTION IN THE NORMAL DOG. R. Steele, J. S. Bishop, A. Dunn, N. Altszuler, I. Rathgeb, and R. C. de Bodo (Brookhaven National Lab., Upton, N. Y. and New York Univ., New York. School of Medicine). [1964]. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The inhibitory effect of insulin on hepatic glucose production in normal dogs was demonstrated using ^{14}C-glucose as a tracer. (C.H.)

14903 (BNL-7954) SIGNIFICANCE TESTS ON THE CRYSTALLOGRAPHIC R-FACTOR. Walter C. Hamilton (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The theory of linear hypothesis tests is discussed in relationship to its use in crystallographic problems. In particular, formulas are developed which allow significance tests on the R-factor ratio $\mathcal{R} = R_1/R_0$, where R_0 and R_1 are respectively the generalized weighted R factors for a structure resulting from an unrestrained least squares refinement and a refinement with restraints on some of the parameters. These tests allow one to decide whether the addition of parameters or the imposition of fixed relationships between parameters results in a significant improvement or a significant worsening of the agreement between observed and calculated structure factors. Tables for determining significance levels of $\mathcal{R}$ are presented, and several applications from the crystallographic literature and from personal experience are discussed. (auth)

14904 (CU-2663-15) DIRECT CURRENT MEASUREMENTS, EQUATORIAL ATLANTIC R/V GERONIMO CRUISE 4. Technical Report No. CU-15-64. Robert Gerard (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Dec. 1964. Contract AT(30-1)-2663. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A description is given of the instruments and techniques used on Research Vessel Geronimo for measuring the currents at various depths, and for taking hydrographic stations, in the Atlantic Ocean between 4 and 8°W and 5°N to 2°S. (T.F.H.)

14905 (CU-2663-16) SOME HYDRODYNAMIC PROBLEMS FOR A NEPHELOID ZONE. Takashi Ichiye (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Dec. 1964. Contract AT(30-1)-2663. 28p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A layer of a few hundred meters' thickness with suspended matter near the bottom on the continental slope of the North Atlantic (a nepheloid zone) discovered by Ewing and Thorndike seems to produce bottom currents, because heavier water near the bottom due to suspended matter slides down the slope. When only the Coriolis' force balances with this gravity effect, the bottom current flows southwestwards along the slope with the maximum velocity of about 10 (cm/sec) for a slope of one degree. The effect of gravity on a fluid in hydrostatic equilibrium with locally variable density above the sloping bottom is discussed, and the extra term due to the density gradient along the slope is derived. The vertical profiles of the currents are determined when the vertical eddy viscosity works beside the Coriolis' force. Two kinds of eddy viscosity distributions estimated from the observed nepheloid distributions are used: constant but different values at two layers and the value increasing with height. The effect of eddy viscosity whose values range 10 to 100 (cm^2/sec) produces Ekman spiral in the layer of about 30 meters thick near the bottom. The effect of the change of density along the bottom is treated by introducing dimensionless variables. Rossby number of the nepheloid current is about 10^{-2} when the current of 10 cm/sec is assumed to develop within a distance of 100 km, indicating that inertia terms are not important in the nepheloid zone. The dimensionless equations are applied to turbidity currents, which have Rossby numbers of 2 (in a decaying area) to 5 (developing area). Thus, the inertia terms are more important to turbidity currents than

Coriolis' force. An analogy of these currents with jet flows in a rotating tank based on their Rossby numbers is discussed. (auth)

14906 (HW-SA-3317) A DEVICE FOR RECORDING AIR CONCENTRATIONS OF ZINC SULFIDE FLUORESCENT PIGMENT ON A REAL TIME SCALE. P. W. Nickola, M. O. Rankin, M. F. Scoggins, and E. M. Sheen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 10, 1964. Contract AT(45-1)-1350. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A sampler probe is described for monitoring air concentrations of a phosphorescing tracer. In the probe, the pigment is exposed to uv and its phosphorescence is observed with a multiplier phototube. Calibration procedures are described, and preliminary results from a field test are presented. (D.L.C.)

14907 (HW-SA-3353) WAFERING OF BULK SPECIMENS FOR TRANSMISSION ELECTRON MICROSCOPY. B. Mastel and H. E. Kissinger (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 6, 1964. Contract AT(45-1)-1350. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A simple technique for preparing wafers with plane parallel sides from bulk specimens is described. Evidence is presented that the worked layer introduced by the wafering action is removed during subsequent chemical or electrolytic thinning required for transmission electron microscopy. (auth)

14908 (HW-SA-3385) A STREAM DRIFT SAMPLER. C. E. Cushing, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Feb. 28, 1964]. Contract AT(45-1)-1350. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A description is given of a sampler for the quantitative sampling of organic drift in streams. The sampler includes an intake and a collecting net fitted into the discharge end of the intake funnel. The efficiency and use of the sampler are discussed. (D.L.C.)

14909 (HW-SA-3414) FLAME-STRAIGHTENING STRUCTURAL MEMBERS. E. B. LaVelle (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.) and R. R. Miles (Clark Equipment Co. Brown Trailer Div., Reading, Penna.). [Mar. 12, 1964]. Contract AT(45-1)-1350. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Misalignment of structural steel members can be corrected by heating with the oxy-acetylene torch. The principles of the method are described briefly, and some examples of the application of the method are given. (D.L.C.)

14910 (LF-20) ULTRAMICRO METHODS IN BIOCHEMISTRY. V. A COMPARISON OF THE ULTRAMICRO DETERMINATION OF PHOSPHORUS USING N-PHENYL-p-PHENYLENEDIAMINE OR 1-AMINO-2-NAPHTHOL-4-SULFONIC ACID. VI. THE DETERMINATION OF SERUM ALKALINE PHOSPHATASE. Technical Progress Report. E. Van Stewart and Bernard B. Longwell (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Dec. 1964. Contract AT(29-2)-1013. 22p. Dep.; $0.50(OTS).

An ultramicro method was developed for the determination of serum inorganic phosphorus which uses 1-amino-2-naphthol-4-sulfonic acid as the reducing agent. This procedure is compared to an ultramicro method which applies the reaction induced by N-phenyl-p-phenylenediamine. The acceptable wavelengths for the measurement of absorbance in both methods of analyses were investigated and are discussed. The two methods are comparable in reproducibility and give results which justify the use of either one for the determination of phosphorus. The method using 1-amino-2-naphthol-4-sulfonic acid was applied to the determination of serum alkaline phosphatase with a substrate consisting of β-glycerophosphate in a barbiturate buffer at pH 9.3. The ultramicro method is compared to the macro method from which it was derived. The comparisons of results with the two procedures are within acceptable limits to justify recommendation of the ultramicro method for the determination of alkaline phosphatase. (auth)

14911 (MLM-1216) MOUND LABORATORY PROGRESS REPORT FOR AUGUST 1964. J. F. Eichelberger, G. R. Grove, and L. V. Jones (Mound Lab., Miamisburg, Ohio). Aug. 20, 1964. Contract AT-33-1-GEN-53. 45p. Dep.; $2.00(cy), 1(mn) OTS.

Only about $\frac{1}{4}$ of the maximum theoretical pressure was achieved for the He-3 thermal pump. Extension of the heating cycle should insure heating of the gas to the proper temperature. The superconducting magnet was operated satisfactorily at about 5 kilogauss. A check on the derivation of the theory of the thermomolecular pressure difference was completed. Ne-21 was enriched to a maximum of 55% in the 48-foot cascade. Calculations for a four-column cascade show that the Ne-21 should increase to a peak of 50%, where it would furnish a highly enriched feed stream for another 36-foot column. The Ar-36 concentration is slowly increasing. The calcium purification system shows the capability of purifying the 94.5% argon to 99.3% Ar in four passes. The second-stage enrichment of Kr-78 and -80 was started. With a product draw-off of about 10 milliliters per hour, the concentration of Kr-78 and -80 in the product leveled off from a peak of over 40% to about 30%. Measurements by internal-gas-phase proportional counting were made of 1951 atmospheric krypton and of feed and product material from thermal diffusion columns. Kr-85 activity in feed gas was 8.3 times that of 1951 Kr, whereas the activity in the product gas was 3.8 times that of the 1951 Kr. Therefore, the product-to-feed Kr-85 ratio was 0.46 ± 0.02. A regular draw-off of Xe-136 product at about 30 milliliters per day from the five-stage swing system has gradually brought the concentration of Xe-131 in the product to about 0.85%. The computer program was used to determine the thermal diffusion column parameters H and K for the Xe-131-132-134-136 system for both the 12-foot concentric tube columns and the 24-foot hot-wire columns. An increasing value for cleanup, with decreasing column temperatures, was obtained using some form of temperature programming. The use of Pentone Formula 676 with dry ice gave a temperature of 193°K, which was only 1.6°K lower than trichloroethylene and dry ice. An ethanol bath which can be readily cooled down to −112°C or lower, or warmed as necessary, was prepared; it may eliminate the need for two baths in temperature programming. The extra stage added to the methane thermal diffusion cascade is expected to improve performance on natural abundance feed. A commercial source of ultra-high-purity methane now available is being used as feed. The supply of enriched C-13, which is now being separated at a rate of one gram per month, now totals 4.9 grams at about 90% enrichment. Stainless steel wire screen was used to replace the glass beads to reduce holdup in the reactor of the carbon dioxide-carbamate chemical exchange system. Some trial runs have indicated the presence of parasitic currents which caused dilution. A complete set of static and flow experiments was run for methane at a wire temperature of 300°C. The assumed value of the thermal diffusion factor, α, was compared with experimental values and values calculated from the Lennard-Jones potential. A computer program to calculate the concentration distributions of a multicomponent system in a static thermal diffusion column was written. It was run successfully for systems containing up to four components. The program shows rapid convergence of the method used to solve a system of simultaneous equations. Alpha-gamma coincidence measurements on polonium sources were performed using large-area and small-area detectors. Significantly better resolution was obtained with the small-area detector, and count rates up to about 10^6 cpm can be used before pile-up effects in the amplifier begin to overcome the other advantages. Six sources of polonium-210 are being counted at irregular intervals to redetermine the half life of the isotope. The half life value was found to be 139.3 ± 0.1 days, as compared with the accepted value of 138.401 ± 0.001 days. The poor extraction of plutonium from U-234 by thenoyltrifluoroacetone (TTA)

was remedied by a valence adjustment step. Extraction of Pu(IV) reduced the plutonium concentration by a factor of 40 in one solution, to 80 ppm in 1.1 grams of U-234. Two additional series of denitration experiments were run using glucose without catalyst to determine the efficiency as well as the completeness of the reaction. Efficiency values ranged from 17 to 8, and the amount of unreacted organic material varied from 1% in 10 N HNO_3 to about 8% in 2 N HNO_3. Ac-227 product, which was radiochemically pure at the time of separation, was obtained from a purification column containing Dowex resin (AG50W-X8, 100-200 mesh). Gas bubbles which had formed in the resin and which impeded the flow rate, were removed by the motion of a stainless steel rod up and down in the resin. Iron and aluminum impurities can be removed if the volume of 2 M HCl is increased from 75 ml to 125 ml. The desorption order of barium-140 and lanthanum-140 is reversed by leaching with an alcohol and HCl mixture, and the degree of reversal may be effected by the nature of the alcohol and the pretreatment of the glass surface. Water and methanol, as well as a mixture of the two, desorbed Ba-140 preferentially at room temperature. Addition of HCl to methanol resulted in essentially complete desorption of both La-140 and Ba-140 from the dried residue. Tests show that the reversal occurs in a platinum container as well as in glass when ethanol plus 10% 12 N HCl are used. An error was discovered in the procedure for calculating probable errors in the variational method when a double variation was necessary, as in the case of a double exponential. The error was small in all reported half-life results. The agreement between the classical general method and the variational method is now remarkably close—within one or two percent of a probable error. There are now four programs by which double exponentials can be solved by Least Squares with an IBM 1620. Twenty-seven measurements added to the half-life calculations of the Po-208 and -209 sample indicate that the half life of Po-208 has increased from 1053.50 days to 1057.08 days, and the half life of Po-209 has increased from 16.11 years to 41.56 years. The latter is only 2.9 internal probable errors less than the currently accepted half life of 100 years. The half life for Po-208 is 1058.11 ± 0.007 days if the half life of Po-209 is assumed to be 100 years. The sample was opened and the alpha ratio is being measured with a pulse height analyzer to determine the probable error in each half life. A new sampling technique developed for infrared spectrometry enables the study of traces of volatile materials in viscous samples to be made. The technique includes heating the sample to about 100°C in a partially evacuated infrared gas cell and obtaining the resultant spectrum, along with the spectrum of any related vapors obtained at room temperature. If sufficient spectral intensity can be obtained a material can be identified. The ability of the Monsanto Capillary Extrusion Rheometer to detect differences in extrusion conditions or variations in plastics formulations was determined. The test material was asbestos-filled diallyl phthalate molding powder. Even slight variations caused by different reaction temperatures, die orifices, crosshead speeds, catalyst concentrations, and inhibitor concentrations were readily detected by the instrument. Tensile strength and ultimate elongation tests of several unfilled polyurethane-based adhesives showed that one formulation (MA 113) exhibited a tensile strength equal to that of the better epoxy adhesive with higher ultimate elongation. Seven of these adhesive formulations were cured at room temperature for 18 hours, aged for 24 hours at 160°F, and the total shrinkages were calculated. MA 113 exhibited the least shrinkage of those tested. The epoxy-polyamide adhesives increased in size during the post-cure, apparently because of gas formation. Addition of asbestos filler interfered with the cure of the polyurethane adhesives. (auth)

14912 (NYO-1938-2) ELECTRO-OSMOSIS IN CONCENTRATED AQUEOUS SOLUTIONS. Technical Progress Report. (New York Univ., New York). [195?]. Contract AT(30-1)-1938. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A method and an apparatus for studying electro-osmosis in concentrated aqueous solutions are described. Preliminary experiments on 1M $AgNO_3$ solutions were carried out which show the existence of a small but significant electro-osmotic flow. The volume/current ratio of 0.013 $cm^3 gm^{-1} s$ for these solutions is compared with the ratios for dilute solutions of three sulfates. (D.L.C.)

14913 (NYO-2462-1A) MONTE CARLO COMPUTATIONS OF TISSUE CELL GROWTH. Final Summary Report. Joseph G. Hoffman (New York. State Univ., Buffalo). Dec. 1, 1964. Contract AT(30-1)-2462. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Digital computer programs were developed for the Maniac I and II and IBM 704, 1620, 7040, and 7090 for use in Monte Carlo computations of cell growth. A model system of cell growth was used in which several parameters could be measured. These included the effects of volume growth, generation time, ratio of cytoplasm to nuclear volume, and effects of ploidy. Interpretation of the results for several cell types is discussed. (C.H.)

14914 (NYO-2471-7a) LOW-TEMPERATURE DIELECTRIC PHENOMENA IN DOPED IONIC CRYSTALS. Report No. 312. H. S. Sack and M. C. Moriarty (Cornell Univ., Ithaca, N. Y.). Jan. 27, 1965. Contract [AT(30-1)-2471]. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Observations are presented on the dielectric behavior of CN^- and NO_2^- ions in potassium halide crystals at low temperatures. The effect of CN^- on the dielectric constant of KCl follows a 1/T law, and a dipole moment of 0.30 D is calculated for the CN^- ion. The frequency-independent behavior and δ constancy indicate that the dipoles can still follow field oscillations and that the process cannot be free rotation. Similar results were obtained for CN^- in KBr and KI and for NO_2^- in KCl (0.21 D moment of NO_2^- ion). However, for NO_2^- in KI, an anomalous dispersion occurs at ~10°K, with a moment of 0.97 D and a relaxation activation energy of 0.0145 ev. Some possible explanations for this effect are given. (D.L.C.)

14915 (NYO-2811-21) ANELASTIC RELAXATIONS DUE TO POINT DEFECTS IN CRYSTALS. B. S. Berry (International Business Machines Corp., Yorktown Heights, N. Y.). Feb. 2, 1965. Contract AT(30-1)-2811. 54p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The theory of anelastic relaxation due to the stress-induced ordering of point defects in crystals is described in an elementary manner. Attention is focussed on the use of internal friction measurements to obtain information about the symmetry and mobility of point defects. Experimental studies of relaxation phenomena attributable to various point defects in metallic, semiconducting and ionic crystals are reviewed, with emphasis on work which has appeared in the last two years. (auth)

14916 (ORNL-3634) COMMUNITY ORGANIZATION AND ENERGY RELATIONSHIPS IN PLANKTON. Bernard C. Patten (Oak Ridge National Lab., Tenn. and Virginia Inst. of Marine Science, Gloucester Point). Feb. 1965. Contracts [W-7405-eng-26] and Nonr-3894(00) (NR-104-581). 65p. Dep.; $3.00(OTS).

Results are reported from a series of studies on the annual phytoplankton cycle in the lower Chesapeake Bay. The principal species are enumerated and major seasonal and spatial patterns are described. Data are included from studies on the diversity-productivity relationships in the lower York River; dark and light bottle experiments on production variables as functions of collection and suspension depth, in which ^{14}C was used as a tracer in cultures of Skeletonema costatum and Nitzschia closterium; calorimetry measurements on diatoms and flagellates, the development of a descriptive mathematical model of planktonic energy-depth relationships; and analog computer studies on generalized plankton ecosystems. (C.H.)

14917 (SC-R-64-1314) A COMMUNICATION SYSTEM WITH ADAPTIVE DECODING. A. M. Breipohl and A. H. Koschmann (Sandia Corp., Albuquerque, N. Mex.). Dec. 1964. Contract [AT(29-1)-789]. 20p. (CONF-776-8). Dep.(mn); $1.00(cy), 1(mn) OTS.

From National Electronics Conference, Chicago, Oct. 1964.

The results of a study of adaptive communication systems in which the learning is based on Bayes' Theorem are presented. The learning is then used to guide adaptation whose purpose is to optimize system performance. Performance is evaluated by a measure based on decision theory. The communication system model used is a binary symmetric channel where "r" denotes the probability of correct transmission, and it is assumed that only the decoding is adaptable. Assuming a time invariant unknown r, it is shown that the true value of r will be learned in the limit, if, and only if, there is some redundancy in the message. It is also shown that the proposed adaptive system will converge to the best possible system if the true value of r is learned. The speed of convergence is measured by the probability that the best possible decoding system is selected after n messages have been received. This measure is calculated for a sample adaptive system in order to show the effect of redundancy in the transmitted message, the number of messages received, and the true value of r. (auth)

14918 (SC-RR-64-602) A CONTROLLED THERMAL ENVIRONMENT FOR DIELECTRIC BREAKDOWN STRENGTH STUDIES. L. J. Seligman (Sandia Lab., Albuquerque, N. Mex.). Feb. 1965. Contract W-7405-eng-48. 22p. Dep.; $2.00(cy), 1(mn) CFSTI.

A glass temperature chamber has been designed in which the dielectric strength of material specimens may be tested in a dielectric fluid. The temperature range of the chamber (−10 to +210°C) is established in an auxiliary heat exchanger which supplies or removes heat as the dielectric fluid is pumped to the specimen, raising or lowering its temperature. Data from two studies of dielectric strength versus temperature, using high-voltage pulses, are compared with theory. (auth)

14919 (SC-RR-64-1689) STATIC PRESSURES ON CONE-CYLINDERS IN SLIP TO TRANSITION FLOWS. K. J. Touryan (Sandia Lab., Albuquerque, N. Mex.). Jan. 1965. Contract AT(29-1)-789. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Static pressures on 50-degree-cone-cylinder probes have been measured in a 1.0 to 11.0 Mach range. Free stream Knudsen numbers $0.01 < Kn_D < 10$ (corresponding free flight altitude range, 200,000 to 450,000 feet) were measured at various locations aft of the cone-cylinder joint. Various rarefaction effects are studied and pressure data are correlated with respect to a modified interaction parameter, x_L, which ranges from 0.1 to 500. (auth)

14920 (SC-TM-64-1708) TIME OF FREE FLIGHT AND MINIMUM ENERGY FOR ELLIPTICAL TRAJECTORIES. G. V. Barton (Sandia Lab., Albuquerque, N. Mex.). Nov. 1964. Contract [AT(29-1)-789]. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Time of free flight and minimum energy calculations versus surface range (500 n.m. to 10,000 n.m.), reentry velocity and angle, were made on the 1604 C.D.C. computer. The resulting calculations are presented in graphical form. (auth)

14921 (SC-TM-64-2146) A MODULARIZED CARD-RACK SYSTEM FOR AUTOMATED DATA SYSTEMS. N. T. Radman (Sandia Lab., Albuquerque, N. Mex.). Dec. 1964. Contract AT(29-1)-789. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A modular rack system for plug-in circuit cards is described which is based on a concept of utility volumes. Utility volume dedication and modular dimensioning are discussed and specific hardware and tooling are described. (auth)

14922 (SCR-722) LOW-DETONATION-PRESSURE EXPLOSIVES. M. T. Abegg (Sandia Corp., Albuquerque, N. Mex.); H. J. Fisher, H. C. Lawton, and W. T. Weatherill (Aerojet-General Corp., Downey, Calif.). Dec. 1964. Contract AT(29-1)-789. 22p. (CONF-117-46). Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Studies were made of plastic/explosive formulations using PETN, RDX, lead azide, and thallous azide in combination with polyurethane, nitropolyurethane, and dinitropropyl acrylate. Surfactants were also used to increase the extrudability. The compatibility and stability of the formulations were determined, and the detonation velocity, pressure, output, and sensitivity were measured. The detonation pressures were found to range from 25 to 160 kilobars; very low pressures were obtained with lead azide/polyurethane systems. The effect of particle size on explosion initiation is discussed. (D.L.C.)

14923 (TID-3727) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period, December 1964–January 1965. (Division of Technical Information Extension, AEC). 18p. Free (DTI Extension, AEC)

A total of 98 references is presented to bibliographies issued or in preparation. The references are arranged according to issuing agency. Subject, author, and report number indexes are included. (D.L.C.)

14924 (TID-21588) ROOT EXTENSION IN A PLANTATION OF LONGLEAF PINE: INVESTIGATION OF A TECHNIQUE USING I-131. Frank W. Woods (Duke Univ., Durham, N. C. School of Forestry). [1963]. Contract AT(40-1)-2790. 129p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Iodine-131 was used as a tracer in field studies to determine the extent of tree roots and to estimate root extension at 3 different soil depths in a plantation of longleaf pine, Pinus palustris. The ^{131}I was applied directly to a sterilized spot in the soil either on the surface or at a depth of 1 or 3 ft and subsequent measurements were made of the radioactivity of the bole of selected trees in the vicinity. A portable scintillation counter was used. If radioactivity was detected in a tree, it was assumed that the tree had root connections with the point of application. Results indicated that all trees over 3 in dbh that were within 10 ft of the point of application absorbed ^{131}I regardless of soil depth. Absorption from the most distant point of application was 22 ft for surface application and 33 ft for applications at 1 and 3 ft depths. Between these distances the number of trees showing radioactivity decreased with increasing distance from the point of ^{131}I application. Data are included from studies on the effect of soil sterilization on the tree roots, the volume of soil made radioactive by the ^{131}I used, and the retention of ^{131}I by clay colloids and organic matter in the soil. (26 references). (C.H.)

14925 (TID-21617) BIOCLIMATIC AND SOILS INVESTIGATIONS IN FOREST ENVIRONMENTS. X. RING ANALYSIS OF SELECTED TREES AT NEOTOMA. Final Report. Richard L. Phipps (Ohio State Univ., Columbus and Ohio. Agricultural Experiment Station, Wooster). Aug. 1964. Contract AT(11-1)-552. 166p. Dep.(mn); $5.00(cy), 3(mn) OTS.

A study was made of the growth rings of trees and the effects of environment on growth. The study was made on suppressed, sub-canopy chestnut, oak and red maple trees growing on opposing slopes in Neotoma Valley, Hocking County, Ohio. Data are presented on the form characteristics of growth rings of the trees and the effects of environmental variables on growth. (52 references). (C.H.)

14926 (TID-21620) LIST OF AEC RADIOISOTOPE CUSTOMERS WITH SUMMARY OF RADIOISOTOPE SHIPMENTS, FY 1964. P. S. Baker (Oak Ridge National Lab., Tenn.). Contract [W-7405-eng-26]. 96p. Dep.; $3.00 (OTS).

Four lists are presented which give the radioisotope sales during FY 1964 by AEC facilities. The lists are: an alphabetical list of customers with isotopes purchased, an alphabetical list of isotopes cross-referenced to customers, an alphabetical list of states and countries cross-referenced to customers, and a table of isotopes and a breakdown into shipments, quantities, and dollars. (D.L.C.)

14927 (UCRL-7588) POWERS OF POWER SERIES. Richard E. von Holdt (California. Univ., Livermore.

Lawrence Radiation Lab.). Nov. 5, 1963. Contract W-7405-eng-48. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A theorem is given relating the coefficients in a given power series (say S) with the coefficients of S^n. (T.F.H.)

14928 (UCRL-7865-T(Rev.I)) EVALUATION OF SPECTRAL VERSUS GRID METHODS OF HEMISPHERIC NUMERICAL WEATHER PREDICTION. Hugh W. Ellsaesser (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 1964. Contract W-7405-eng-48. 126p. Dep.(mn); $4.00(cy), 2(mn) OTS.

Using observed hemispheric meteorological data as initial conditions, typical barotropic (one-level) filtered-equation numerical weather prediction models were integrated both by the conventional grid-point method and by the spectral method proposed by Silberman in 1954. For integrations spanning a hemisphere (or sphere) and for comparable space truncation measured in terms of phase speeds, the spectral method was found to be about twice as efficient in terms of computation time on the IBM 7094. Also, compared with most grid-point methods, it is far superior in preserving the quadratic integral invariants of the differential equations and it eliminates the cascade of energy into the smallest resolvable scales. The only discovered disadvantages of the spectral method arise if tendency terms are multiplied by space-dependent variables, or if forcing terms are more than quadratic in space variables. In the former case tendency equations for the expansion coefficients cannot be uncoupled; this requires inversion of a matrix each time step and in the latter case higher order interactions occur which complicate the integration. These difficulties can be circumvented by replacing undifferentiated space variables by their mean values or by use of a primitive-equation model in which such terms do not occur. To provide initial data for these comparative integrations, IBM 7094 machine-language programs were developed to interpolate objective analyses to a latitude-longitude grid and to compute surface spherical harmonic expansion coefficients from the interpolated data. (auth)

14929 (UCRL-12168) SOME 1:1 COMPLEXES OF CYCLOMETHYLENETETRANITRAMINE (HMX) AND THEIR APPLICATION TO THE ESTIMATION OF HMX IN ADMIXTURE WITH RDX. Walter Selig (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 1964. Contract W-7405-eng-48. 25p. Dep.(mn); $2.00(cy), 1(mn) OTS.

1:1 complexes of HMX were prepared with N,N-dimethylformamide, N,N-dimethylpropionamide, N,N-dimethylacetamide, N,N,N′,N′-tetramethylurea, 1-methyl-2-pyrrolidinone, cyclopentanone, 2-cyclopentanone, 2-cyclohexene-1-one, and γ-butyrolactone. Infrared spectra, x-ray data, differential thermal analysis, and photomicrographs of the complexes are presented. RDX does not complex with any of the compounds; hence a simple method for the estimation of HMX in admixture with RDX is available. (auth)

14930 (UNM-TR-EE-120) A MONOPOLE ANTENNA DRIVEN WITH RESPECT TO A SMALL DISC. R. H. Williams (New Mexico. Univ., Albuquerque. Engineering Experiment Station). Dec. 1964. For Sandia Corp., Albuquerque, N. Mex. Contract AT(29-1)-789. 32p. (SC-DC-64-2098). Dep.(mn); $2.00(cy), 1(mn) OTS.

A monopole antenna driven with respect to a small disc located above an earth of finite conductivity is analyzed theoretically. No initial restriction is placed on the current distributions on the monopole or the disc surfaces. A variational (Ritz) technique is used to derive a formula for the driving point impedance of the antenna, and simultaneously, to approximate the current distributions. An asymptotic technique is used to derive expressions for the radiated fields in the antenna's far zone. (auth)

14931 EURATOM 1964—REVIEWS AND PROJECTION. P. Baehr. Neue Tech., 6: 243-9(Oct. 1964). (In German)

The present state of the principal research programs of Euratom is briefly summarized. The reactor program, studies on controlled thermonuclear reactions, processing of fuel elements, and treatment of radioactive waste products are discussed. The adaptation of the second five-year program is considered. (J.S.R.)

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The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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Reports, conference papers and proceedings, numbered translations, and patents abstracted during the period are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show, when known, which reports are on file in the depository libraries, which reports have been published in open-literature journals (journal citation given), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, cross references from secondary to primary report numbers are cited.

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Conferences

Beginning with Volume 19, Number 1, new receipts of conference proceedings as well as individual papers from conferences will be included in this index. When a paper is received from a conference a distinctive number will be assigned to the conference in the form CONF-year-month-sequence. Individual papers will be numbered with this basic "CONF" number and in addition each will carry a further sequence number. For example, the first paper received from a conference held in January 1965 would be numbered CONF-650101-1. Conference proceedings from which no individual papers have been received will be similarly numbered with a basic number. When proceedings are abstracted the abstract will appear at the point of the basic "CONF" number for the conference. Since all information on conferences will be included in this Report Number Index the subject heading CONFERENCES will be discontinued with Volume 19, Number 1.

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613-59	19-13699	Dep.(mn); $5.00(cy), 3(mn) OTS
BM-RI–	**(Misc.)**	
6570	19-13870	Dep.(mn); $1.00(cy), 1(mn) CFSTI
BMI–	**(Misc.)**	
1691(Del.)	19-13871	Dep.; $3.00(cy), 2(mn) CFSTI
BNL–		
869	19-14895	Dep.; $2.75(cy), 5(mn) CFSTI
888	19-14308	$1.75(CFSTI)
892	19-13872	Dep.; $3.00(CFSTI)
896	19-14896	Dep.; $3.00(CFSTI)
897	19-14503	Dep.; $3.00(cy), 2(mn) CFSTI
904	19-14504	Dep.; $1.00(cy), 1(mn) CFSTI
7664-R	19-13578	Dep.(mn); $2.00(cy), 1(mn) CFSTI Intern. J. Heat Mass Transfer, 8: 303-15(1965)
7803	19-14897	Dep.(mn); $4.00(cy), 2(mn) CFSTI
7804	19-13567	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7830	19-13700	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7837	19-12903	Dep.; $1.00(cy), 1(mn) CFSTI
7850	19-14898	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7851	19-13579	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7881	19-13621	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7909	19-14899	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7936	19-14900	Dep.(mn); $2.00(cy), 1(mn) CFSTI Anal. Biochem., 10: 53-72(1965)
7942	19-14901	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7944	19-14902	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7954	19-14903	Dep.(mn); $2.00(cy), 1(mn) CFSTI
8077	19-14261	Phys. Chem. Solids, 26: 203-7(1965)
8508	19-14505	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8509	19-14309	Dep.(mn); $3.00(cy), 1(mn) CFSTI
8526	19-14310	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8561	19-14167	Dep.(mn); $2.00(cy), 1(mn) CFSTI
8663	19-14125	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8676	19-14168	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8710	19-14506	Dep.(mn); $2.00(cy), 1(mn) CFSTI
8745	19-14507	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8782	19-14169	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8790	19-14170	Dep.(mn); $2.00(cy), 2(mn) CFSTI
8808	19-13195	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8858	19-14508	Dep.(mn); $2.00(cy), 1(mn) CFSTI
CEA-R–	**(French)**	
2493	19-14659	Dep.(mn)
2562	19-13846	Dep.(mn)
2567	19-13272	Dep.(mn)
2582	19-13092	Dep.(mn)
2590	19-12908	Dep.(mn)
2617	19-14660	Dep.(mn)
2624	19-14509	Dep.(mn)
CEA-tr–	**(French)**	
R-1763	19-13708	Dep.(mn); $2.60(fs), $0.83(mf) JCL
R-1799	19-14145	Dep.(mn); $5.60(fs), $1.94(mf) JCL
R-1814	19-14331	Dep.(mn); $2.60(fs), $1.10(mf) JCL
CERN–	**(European Organization for Nuclear Research)**	
64-43	19-14171	
CEX–		
59.4.10	19-13622	Dep.; $1.00(CFSTI)
59.4.24	19-13623	Dep.; $1.00(CFSTI)
63.7	19-13664	Dep.; $2.00(CFSTI)
CLM-P–	**(British)**	
35	19-14686	J. Nucl. Energy, Pt. C, 7: 15-28(1965)
CNAEM–	**(Turkish)**	
21(Pt.1)	19-13198	Dep.(mn)
CONF-20–	19-13386	**(3rd Rare Earth Conference, Clearwater, Fla., Apr. 1963)**
CONF-117–	**(American Chemical Society 145th National Meeting, New York, Sept. 1963)**	
46	19-14922	See SCR-722
CONF-138–	**(11th Detroit AMACHEM Conference, Detroit, Oct. 1963)**	
3	19-13268	ORINS. Gmelin, AED-CONF-63-199-2
CONF-187	19-13931	**(American Nuclear Society Meeting, New York, Nov. 1963)**
CONF-241–	**(11th International Congress of Genetics, The Hague, Sept. 1963)**	
3	19-12946	ORINS
CONF-258–	19-14775	**(Sodium Components Development Program Meeting, Palo Alto, Calif., Aug. 1963)**
CONF-396–	19-14485	**(Symposium on Nuclear Spectroscopy with Direct Reactions, Argonne, Ill., Feb. 1964)**
CONF-446–	**(American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964)**	
45	19-14822	Dep.(mn); $1.00(cy), 1(mn) CFSTI; Gmelin, AED-CONF-64-081-46

Report No.	Abstract No.	Availability
CONF-456–		**(18th Annual Symposium on Fundamental Cancer Research and Cellular Radiation Biology, Houston, Tex., Mar. 1964)**
7	19-13120	ORINS. Gmelin, AED-CONF-64-034-6
CONF-492–		**(National Association of Corrosion Engineers, Chicago, Mar. 1964)**
8	19-13918	See WCAP-5368
CONF-521–		**(5th Space Science Symposium, Florence, May 1964)**
3	19-14199	See MIT-2098-99
CONF-550–		**(The International Conference on High-Energy Physics, Dubna, August 5–15, 1964)**
86	19-14314	See JINR-P-1887
CONF-555		**(International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964)**
5	19-13696	ORINS. Gmelin, AED-CONF-64-083-6
CONF-556–		**(12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964)**
5	19-13087	ORINS. Gmelin, AED-CONF-64-078-13
7	19-13088	ORINS. AED-CONF-64-078-20
10	19-13089	ORINS. Gmelin, AED-CONF-64-078-16
12	19-13091	ORINS. Gmelin, AED-CONF-64-078-4
13	19-13090	ORINS. Gmelin, AED-CONF-64-078-3
CONF-564–		**(Colloquium on Interaction Between Electromagnetic Waves and Plasma, Saclay, France, Sept. 1964)**
3	19-14291	See GA-5552
CONF-617	**19-4539**	**(Special Technical Conference on Nuclear Radiation Effects, Seattle, Wash., July 1964)**
11	19-13815	ORINS. Gmelin, AED-CONF-64-116-5
12	19-14113	ORINS. Gmelin, AED-CONF-64-116-19
13	19-13806	ORINS. Gmelin, AED-CONF-64-116-25
14	19-13820	ORINS. Gmelin, AED-CONF-64-116-30
15	19-14112	ORINS. Gmelin, AED-CONF-64-116-16
CONF-620–	**19-13694**	**(Institute of Nuclear Materials Management 5th Annual Meeting, Pittsburgh, May 1964)**
CONF-621–		**(IAEA Panel on In-Pile Dosimetry, Vienna, July 1964)**
2	19-14463	See EUR-2179.e
CONF-642–		**(Health Physics Society, Cincinnati, June 1964)**
25	19-12910	See DPSPU-64-30-7B
CONF-650–		**(Linear Accelerator Conference, Madison, Wis., July 1964)**
12	19-14167	See BNL-8561
CONF-651–		**(9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug. 31–Sept. 4, 1964)**
44	19-14433	Dep.(mn); $1.00(cy), 1(mn) CFSTI
45	19-13981	Dep.(mn); $1.00(cy), 1(mn) CFSTI
48	19-14457	ORINS. Gmelin, AED-CONF-64-140-95
49	19-14452	ORINS. Gmelin, AED-CONF-64-140-96
68	19-14650	ORINS. Gmelin, AED-CONF-64-140-43
73	19-14454	ORINS. Gmelin, AED-CONF-64-140-62
76	19-14456	ORINS. Gmelin, AED-CONF-64-140-59
77	19-14450	ORINS. Gmelin, AED-CONF-64-140-58
78	19-14453	ORINS. Gmelin, AED-CONF-64-140-57
79	19-14455	ORINS. Gmelin, AED-CONF-64-140-53
80	19-14451	ORINS. Gmelin, AED-CONF-64-140-63
CONF-654–	**19-2907** **19-6030**	**(American Nuclear Society Meeting, San Francisco, Nov. 30–Dec. 3, 1964)**
26	19-14803	Dep.(mn); $1.00(cy), 1(mn) CFSTI
27	19-14510	Dep.(mn); $1.00(cy), 1(mn) CFSTI
29	19-14472	See WAPD-T-1718
34	19-13735	See ORNL-P-993
35	19-14827	See GA-5411
36	19-13419	See AGN-TP-110
CONF-714–		**(Conference on Nuclear Education in the New Era of Nuclear Power, Gatlinburg, Tenn., Aug. 24–25, 1964)**
4	19-14862	ORINS. Gmelin, AED-CONF-64-144-4
CONF-718–		**(American Institute of Chemical Engineers Meeting, Las Vegas, Nev., Sept. 21, 1964)**
5	19-13565	ORINS. Gmelin, AED-CONF-64-163-5
CONF-720–		**(2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Oct. 1964)**
4	19-14536	See ORNL-P-848
10	19-14535	See ORNL-P-813
CONF-729–		**(International Conference on Beryllium, Philadelphia, Oct. 1964)**
2	19-13936	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3	19-13982	Dep.(mn); $1.00(cy), 1(mn) CFSTI
4	19-13914	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6	19-14068	ORINS
11	19-13975	ORINS
12	19-14073	ORINS
13	19-14072	ORINS
14	19-14071	ORINS
15	19-14070	ORINS
16	19-13976	ORINS
17	19-14069	ORINS
18	19-14076	ORINS
CONF-763–		**(American Society of Mechanical Engineers Winter Meeting, New York, Nov. 29–Dec. 4, 1964)**
10	19-14301	ORINS
13	19-13598	ORINS
15	19-13560	ORINS
22	19-13593	ORINS
24	19-13573	ORINS
25	19-13594	ORINS
27	19-13595	ORINS
28	19-13597	ORINS
29	19-13596	ORINS
31	19-14302	ORINS
CONF-765–		**(2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 3–6, 1964)**
8	19-13626	See HW-SA-3742
CONF-773–		**(Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964)**
9	19-13505	ORINS
10	19-13519	ORINS
11	19-13496	ORINS
12	19-13487	ORINS
13	19-13495	ORINS
14	19-13486	ORINS
15	19-13517	ORINS
16	19-13518	ORINS
17	19-13500	ORINS
18	19-13497	ORINS
19	19-13488	ORINS
20	19-13504	ORINS
21	19-13503	ORINS
22	19-13489	ORINS
24	19-13490	ORINS
25	19-13491	ORINS
26	19-13492	ORINS
27	19-13499	ORINS
28	19-13484	ORINS
29	19-13485	ORINS
30	19-13494	ORINS
31	19-13506	ORINS
32	19-13493	ORINS
33	19-13502	ORINS
CONF-776–		**(National Electronics Conference, Chicago, Oct. 1964)**
8	19-14917	See SC-R-64-1314
CONF-801–		**(Panel on the Molecular Basis of Radiosensitivity, Vienna, Nov. 16–20, 1964)**
2	19-12947	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3	19-12948	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-804–		**(Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 15–19, 1964)**
3	19-14077	ORINS

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4	19-13401	ORINS
5	19-14078	ORINS
10	19-14075	ORINS
23	19-14079	ORINS
CONF-811–		(9th Yugoslavian Summer Meeting of Physicists, Hercegnovi, Yugoslavia, July 9–31, 1964)
2	19-14310	See BNL-8526
CONF-620902–	19-13382	(International Symposium on Condensation and Evaporation of Solids, Dayton, Ohio, Sept. 12–14, 1962)
CONF-630801–	19-14202 19-14424	(Conference on Artificial Satellites, Blacksburg, Va., Aug. 12–16, 1963)
CONF-630903–	19-13611	(5th International Symposium on Space Technology and Science, Tokyo, Sept. 2–7, 1963)
CONF-630905–		(4th International Conference on Non-Destructive Testing, London, Sept. 9–13, 1963)
1	19-13603	ORINS
2	19-13263	ORINS
CONF-631104–		(Meeting on the Utilization of Research Reactors, São Paulo, Brazil, Nov. 4–8, 1963)
2	19-13498	ORINS
3	19-13501	ORINS
CONF-631201–	19-14810	(Fast Neutron Breeder Reactor Conference, Detroit, Dec. 2–3, 1963)
CONF-640102–		(International Seminar on the Transport Properties of Gases Meeting, Providence, R. I., Jan. 20–24, 1964)
1	19-14140	See NYO-1480-8
CONF-640103–		(7th Refractory Composites Group Meeting, Fort Worth, Tex., Jan. 14–16, 1964)
1	19-13909	ORINS
CONF-640301–	19-14511	(Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kan., Mar. 5–6, 1964)
CONF-640503–		(5th International Pulp and Paper Symposium, Vancouver, B. C., May 18–24, 1964)
1	19-13841	ORINS. Gmelin, AED-CONF-64-110-1
CONF-640606–		(American Physical Society Summer Meeting, Denver, Colo., June 25–27, 1964)
4	19-14647	ORINS. Gmelin, AED-CONF-64-113-22
5	19-14482	ORINS. Gmelin, AED-CONF-64-113-21
6	19-14727	ORINS. Gmelin, AED-CONF-64-113-19
7	19-14649	ORINS. Gmelin, AED-CONF-64-113-18
8	19-14648	ORINS. Gmelin, AED-CONF-64-113-17
18	19-14521	Dep.(mn); $1.00(cy), 1(mn) CFSTI; ORINS. Gmelin, AED-CONF-64-113-32 Phys. Rev., 137: B1441-5(1965)
CONF-640609–		(Society of Nuclear Medicine, 11th Annual Meeting, Berkeley, Calif., June 17–20, 1964)
1	19-12949	Dep.(mn); $1.00(cy), 1(mn) CFSTI; Gmelin, AED-CONF-64-111-5
CONF-640611–		(Canadian Assn. of Physicists, Division of Medical and Biological Physics, Annual Meeting, Halifax, Nova Scotia, Canada, June 11–13, 1964)
4	19-13805	ORINS. Gmelin, AED-CONF-64-108-2
CONF-640613	19-14895	(Subunit Structure of Proteins Biochemical and Genetic Aspects Symposium, Upton, N. Y., June 1–3, 1964)
CONF-640614–	19-13607	(Symposium on Soil-Structure Interaction, Tucson, Ariz., June 8–11, 1964)
CONF-640701–	19-14299	(International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris, July 6–11, 1964)
113	19-14289	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-640702–		(American Crystallographic Assn. Annual Meeting, Bozeman, Mont., July 26–31, 1964)
5	19-14074	ORINS. Gmelin, AED-CONF-64-137-5
CONF-640801–		(4th Electric Propulsion Conference, Philadelphia, Aug. 31–Sept. 2, 1964)
31	19-13612	ORINS
32	19-13613	ORINS
33	19-13614	ORINS
34	19-13615	ORINS
35	19-14300	ORINS
CONF-640804–		(11th International Congress of Applied Mechanics, Munich, Aug. 30–Sept. 5, 1964)
1	19-14664	See JHU-23-P
CONF-640903–		(American Vacuum Society Symposium, Chicago, Sept. 30–Oct. 2, 1964)
1	19-14179	See SLAC-PUB-52
5	19-13616	ORINS. Gmelin, AED-CONF-64-171-14
CONF-640908–		(11th Ottawa Symposium on Applied Spectroscopy and Analytical Chemistry, Ottawa, Sept. 9–11, 1964)
1	19-13264	ORINS
2	19-13267	ORINS. Gmelin, AED-CONF-64-275-1
3	19-13265	ORINS
4	19-13266	ORINS
CONF-640910–		(International Convention on Military Electronics, Washington, D. C., Sept. 14–16, 1964)
1	19-13868	ORINS. Gmelin, AED-CONF-64-169-1
2	19-13817	ORINS. Gmelin, AED-CONF-64-169-2
CONF-640911–		(Symposium on Chromatography, Brussels, Sept. 14–15, 1964)
1	19-13522	See EUR-2191.n
CONF-641004–		(American Physical Society, Chicago, Oct. 23–24, 1964)
1	19-14506	See BNL-8710
CONF-641005–		(Correlation of Particles Emitted in Nuclear Reactions, Gatlinburg, Tenn., Oct. 15–17, 1964)
1	19-14309	See BNL-8509
2	19-14505	See BNL-8508
CONF-641007–		(American Society of Lubrication Engineers and American Society of Mechanical Engineers Lubrication Conference, Washington, D. C., Oct. 13–16, 1964)
1	19-13840	ORINS
CONF-641009–		(Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y., Oct. 5–7, 1964)
1	19-13818	ORINS. Gmelin, AED-CONF-64-193-6
2	19-13819	ORINS. Gmelin, AED-CONF-64-193-5
6	19-13816	ORINS. Gmelin, AED-CONF-64-193-9
CONF-641011–		(Thermionic Conversion Specialist Conference, Cleveland, Oct. 26–28, 1964)
1	19-14292	See GA-5651
CONF-641013–		(Symposium on Recent Developments in Research Methods and Instrumentation, Bethesda, Md., Oct. 5–8, 1964)
1	19-12902	ORINS. Gmelin, AED-CONF-64-195-1
CONF-641101–	19-13821	(6th Annual Contractors Meeting, Washington, D. C., Nov. 9–10, 1964)
CONF-641111–		(US–Japan Information Exchange Meeting on Ceramic Nuclear Fuels 19th High Temperature Fuels Committee Meeting, Canoga Park, Calif., Nov. 16–18, 1964)
1	19-14235	See LA-DC-6516(Rev.)
CONF-641210–		(American Physical Society Meeting, Berkeley, Calif., Dec. 1964)
1	19-14672	See SU-ML-1261
CONF-650101–		(Mössbauer Symposium, New York, Jan. 26, 1965)

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1	19-14507	See BNL-8745
CONF-650103–	**(International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex., Jan. 11, 1965)**	
1	19-13666	See LA-DC-6866
5	19-13557	See K-D-1845
CONF-650203–	**(National American Institute of Mechanical Engineers Meeting, Chicago, Feb. 14–18, 1965)**	
2	19-13996	See ORNL-P-1051
CONF-650301–	**(Symposium on the Physics and Chemistry of Fission, Salzburg, Mar. 22–26, 1965)**	
1	19-14527	See LA-DC-6673
2	19-14526	See LA-DC-6670
4	19-14508	See BNL-8858
CONF-650401–	**(American Chemical Society, Detroit, Apr. 4–9, 1965)**	
1	19-13531	See ORNL-P-902
2	19-13279	See ORNL-P-925
COO–		
7-0334	19-14609	Nucl. Phys., 65: 156-66(1965)
264-215	19-14311	Dep.(mn); $1.00(cy), 1(mn) CFSTI
382-47	19-14223	Space Sci. Rev., 3: 583-714(1964)
888-42	19-12909	Dep.(mn); $3.00(cy), 3(mn) CFSTI
1095-3	19-12950	Dep.(mn); $4.00(cy), 2(mn) CFSTI
CRC–	**(Canadian)**	
1205	19-13420	Dep.; $1.00(AECL)
CRFD–	**(Canadian)**	
1207	19-14773	Dep.; $0.50(AECL)
CRRP–	**(Canadian)**	
1184(App.1)	19-14786	$3.00(AECL)
1209	19-14881	Dep.; $1.50(AECL)
CU–	**(Misc.)**	
233	19-14312	
2663-13	19-13617	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2663-15	19-14904	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2663-16	19-14905	Dep.(mn); $2.00(cy), 1(mn) CFSTI
CVNA–	**(Misc.)**	
222	19-14823	Dep.(mn); $2.00(cy), 2(mn) CFSTI
D–	**(Misc.)**	
1-82-0362	19-12951	$1.00(CFSTI)
DASA–	**(Misc.)**	
1305	19-14114	$8.60(CFSTI)
1422	19-12952	$3.00(CFSTI)
DESY–	**(German)**	
64/12	19-14522	Dep.(mn)
64/13	19-14172	Dep.(mn)
DMIC–	**(Non-AEC)**	
208(Vol.I)	19-13937	$4.00(cy), 3(mn) CFSTI as AD-608637
DP–		
863	19-13701	Dep.; $1.00(CFSTI)
913	19-13273	Dep.; $2.00(CFSTI)
919	19-14824	Dep.; $3.00(cy), 2(mn) CFSTI
DPSPU–		
63-30-39	19-14864	Dep.(mn); $1.00(cy), 1(mn) CFSTI
64-30-7B	19-12910	Dep.(mn); $1.00(cy), 1(mn) CFSTI
DPST–		
64-83-9	19-14825	Dep.(mn); $1.00(cy), 1(mn) CFSTI
64-83-11	19-14804	Dep.(mn); $1.00(cy), 1(mn) CFSTI
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EANDC-US–	**(European-American Nuclear Data Committee)**	
71(U)	19-14503	See BNL-897
EDR–	**(Misc.)**	
3965	19-14290	$2.00(CFSTI)
EE–	**(Misc.)**	
35	19-14673	See USCEC-103-101
EFINS–	**(Misc.)**	
64-33	19-14311	See COO-264-215
EIR–	**(Swiss)**	
69	19-13867	Numerische Math., 6: 89-97(1964)
EOS–	**(Non-AEC)**	
3130-Final	19-14285	See AD-422661
ER–	**(Misc.)**	
7604	19-14086	See N65-13446
ETR–	**(Belgian)**	
138(Rev.)	19-13529	See NP-14593
EUR–	**(European Atomic Energy Community)**	
1204.n	19-14150	Ingenieursblad, 33: No. 7, 3-19(1964)
1752.e	19-14082	Dep.(mn)
1916.f	19-14660	See CEA-R-2617
2158.f	19-13938	Dep.(mn)
2161.f	19-14462	Dep.(mn)
2179.e	19-14463	Dep.(mn)
2191.n	19-13522	Dep.(mn)
2199.e	19-13523	Dep.(mn)
EUR-C–		
5494/64e	19-14844	See TID-21593
EURAEC–		
1097	19-13939	Dep.(mn); $4.00(cy), 2(mn) CFSTI
1179	19-13874	Dep.(mn); $4.00(cy), 2(mn) CFSTI
1214	19-13939	See EURAEC-1097
1230	19-14826	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1242	19-13940	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1269	19-13274	See GEAP-4544
1299	19-13980	See ATL-A-144
1321	19-13985	See GEAP-4535
FSU–		
2690-14	19-14126	Dep.(mn); $3.00(cy), 1(mn) CFSTI
FTD-TT–	**(Non-AEC)**	
64-591	19-14092	CFSTI
64-592	19-13207	CFSTI
64-803	19-14146	CFSTI
FZK–	**(Non-AEC)**	
9-190	19-13726	See NARF-63-16T
170-2	19-14867	
170-4	19-14868	
170-5	19-14869	
170-6	19-14870	
170-7	19-14871	
170-8	19-14872	
184-3	19-13812	
185	19-14882	
187	19-13624	$6.00(CFSTI)
G–	**(Misc.)**	
3988-3-3	19-13811	See AD-422354
GA–	**(Misc.)**	
4022(Pt.1)	19-13875	Dep.(mn); $4.00(cy), 3(mn) CFSTI
4675	19-13983	Dep.(mn); $2.00(cy), 2(mn) CFSTI
4930(Pt.1)	19-13876	Dep.(mn); $2.00(cy), 1(mn) CFSTI
5016(Pt.1)	19-13877	Dep.(mn); $3.00(cy), 2(mn) CFSTI
5102	19-14039	J. Nucl. Mater., 15: 33-42(1965)
5411	19-14827	Dep.(mn); $1.00(cy), 1(mn) CFSTI
5520	19-13984	Dep.(mn); $2.00(cy), 1(mn) CFSTI
5552	19-14291	Dep.(mn); $1.00(cy), 1(mn) CFSTI
5606(Pt.1)	19-13878	Dep.(mn); $2.00(cy), 1(mn) CFSTI
5651	19-14292	Dep.(mn); $1.00(cy), 1(mn) CFSTI
GEAP–	**(Misc.)**	

Report No.	Abstract No.	Availability
3246(Rev.2)	19-14873	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3446	19-14874	$3.00(cy), 2(mn) CFSTI
4535	19-13985	Dep.(mn); $3.00(cy), 2(mn) CFSTI
4544	19-13274	Dep.(mn); $1.00(cy), 1(mn) CFSTI
4723	19-14828	Dep.(mn); $3.00(cy), 3(mn) CFSTI
GEMP–	**(Misc.)**	
42A	19-13879	Dep.; $2.00(CFSTI)
GEST–	**(Misc.)**	
2036	19-14293	
GNE/Phys–	**(Non-AEC)**	
64-16	19-14875	$4.00(CFSTI)
GSP/Phys–	**(Non-AEC)**	
64-2	19-14287	See AD-603681
64-6	19-14483	See AD-603601
64-12	19-13721	See AD-603608
HPR–	**(Norwegian)**	
40	19-14829	Dep.(mn)
HW–		
76160	19-13568	Dep.(mn); $2.00(cy), 1(mn) CFSTI
78756	19-14876	Dep.(mn); $1.00(cy), 1(mn) CFSTI
80246	19-13858	Dep.(mn); $3.00(cy), 2(mn) CFSTI
80968	19-14787	Dep.(mn); $3.00(cy), 2(mn) CFSTI
81259	19-14805	Dep.; $3.00(CFSTI)
81602	19-13880	Dep.; $3.00(CFSTI)
81984	19-14766	Dep.; $5.00(CFSTI)
82372	19-14884	$3.00(cy), 2(mn) CFSTI
83606	19-13703	Dep.; $3.00(cy), 1(mn) CFSTI
83613	19-12893	Dep.; $2.00(CFSTI)
84106	19-13884	Dep.(mn); $2.00(cy), 1(mn) CFSTI
84214	19-14865	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84329	19-13723	Dep.; $1.00(CFSTI)
84448-10	19-13859	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84451	19-14729	Dep.(mn); $1.00(cy), 1(mn) CFSTI
HW-SA–		
3165	19-14029	J. Nucl. Mater., 13: 137-41(1964)
3317	19-14906	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3319	19-13920	Corrosion, 21: 19-27(1965)
3353	19-14907	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3385	19-14908	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3392	19-13625	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3402	19-12904	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3414	19-14909	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3416	19-13842	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3536	19-13218	Anal. Chem. 37: 252-5(1965)
3607	19-13848	Isotopes Radiation Technol., 2: 99-123 (1964-65)
3664	19-14085	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3742	19-13626	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3779	19-13986	Dep.(mn); $1.00(cy), 1(mn) CFSTI
IA–	**(Non-AEC)**	
983	19-13771	Nucl. Instr. Methods, 32: 70-7(1965)
994	19-14129	
IDO–		
10040	19-14833	Dep.; $2.00(cy), 1(mn) CFSTI
16928	19-14789	Dep.(mn); $3.00(cy), 2(mn) CFSTI
17055	19-14885	Dep.; $2.00(CFSTI)
IEA–	**(Brazilian)**	
71	19-13193	p.371-93 of "Use of Radioisotopes in Animal Biology and the Medical Sciences. Vol. I." New York, Academic Press, 1962
IGC/RKWP–	**(British)**	
P-19	19-13987	See IGR-TM/C-0176
IGR-TM–	**(British)**	
C-0176	19-13987	Dep.(mn)
IITRI–	**(Misc.)**	
578P22-12	19-14774	Dep.(mn); $2.00(cy), 1(mn) CFSTI
B6021-4	19-13885	$1.00(CFSTI)
IPP–	**(German)**	
1/9	19-14661	Dep.(mn)
1/13	19-14662	Dep.(mn)
3/18	19-14294	Dep.(mn)
3/22	19-14663	Dep.(mn)
IPR–	**(Brazilian)**	
43	19-13498	See CONF-631104-2
45	19-13501	See CONF-631104-3
IR–	**(Non-AEC)**	
64-102	19-13530	See NP-14770
IS–		
771	19-13348	J. Nucl. Mater., 13: 142-51(1964)
944	19-13305	Inorg. Chem., 4: 176-81(1965)
965	19-14234	Dep.; $2.00(cy), 1(mn) CFSTI
995	19-13860	Dep.; $4.00(cy), 2(mn) CFSTI
1024	19-14130	Dep.; $2.00(cy), 2(mn) CFSTI
1042	19-13275	Dep.; $2.00(CFSTI)
1065(Rev.)	19-13317	J. Chem. Eng. Data, 10: 33-6(1965)
JHU–	**(Misc.)**	
23-P	19-14664	$2.00(CFSTI)
JINR–	**(Russian)**	
E-1894	19-14313	Dep.(mn)
E-1924	19-14523	Dep.(mn)
P-1847	19-14524	Dep.(mn)
P-1887	19-14314	Dep.(mn)
P-1891	19-14315	Dep.(mn)
P-1892	19-14316	Dep.(mn)
P-1896	19-14317	Dep.(mn)
P-1902	19-14173	Dep.(mn)
P-1906	19-14318	Dep.(mn)
P-1907	19-14525	Dep.(mn)
P-1910	19-14319	Dep.(mn)
P-1912	19-14320	Dep.(mn)
P-1916	19-14403	Dep.(mn)
JPRS–	**(Non-AEC)**	
27535	19-13122	$3.00(CFSTI)
27976	19-13956	$4.00(CFSTI)
27980	19-13903	$1.00(CFSTI)
28330	19-13957	$7.00(CFSTI)
28343	19-14116	$5.00(CFSTI)
28356	19-12894	$1.00(CFSTI)
28565	19-13406	$1.00(CFSTI)
28656	19-14879	$1.00(CFSTI)
JüL–	**(German)**	
181-RC	19-13422	Dep.(mn)
K-D–		
1780	19-13556	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1845	19-13557	Dep.(mn); $2.00(cy), 1(mn) CFSTI
KAPL–		
2165-2	19-14790	Dep.(mn); $4.00(cy), 2(mn) CFSTI
3073	19-13941	Dep.(mn); $3.00(cy), 2(mn) CFSTI
KAPL-M–		
6186(Rev.I)	19-14807	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6430	19-14886	Dep.(mn); $3.00(cy), 2(mn) CFSTI
6431	19-14791	Dep.(mn); $1.00(cy), 1(mn) CFSTI
KFK–	**(German)**	
216	19-13525	Dep.(mn)
217	19-14792	Dep.(mn)
237	19-12945	p.210-21 of "Essays in Coordination Chemistry. Exper. Suppl. IX." Basel, Birkhäuser Verlag, [1964]
243	19-13423	Dep.(mn)
244	19-13402	Dep.(mn)
KLX–	**(Misc.)**	
1866	19-13569	Dep.; $3.00(cy), 2(mn) CFSTI

Report No.	Abstract No.	Availability
KR–	**(Norwegian)**	
86	19-14767	Dep.(mn)
KRB–	**(German)**	
1964/2	19-14844	See TID-21593
KY-L–		
258(Rev.I)	19-14283	Dep.(mn); $1.00(cy), 1(mn) CFSTI
379	19-13526	Dep.(mn); $1.00(cy), 1(mn) CFSTI
LA–		
3060	19-14464	Dep.; $2.00(cy), 1(mn) CFSTI
3157	19-13199	Dep.; $3.00(CFSTI)
3162	19-13276	Dep.; $3.00(CFSTI)
3174	19-14834	Dep.; $2.00(cy), 1(mn) CFSTI
3176	19-13200	Dep.; $1.00(CFSTI)
3181	19-13942	Dep.; $1.00(cy), 1(mn) CFSTI
3184	19-13277	Dep.; $2.00(cy), 1(mn) CFSTI
3186	19-14465	Dep.; $3.00(cy), 1(mn) CFSTI
3191	19-13988	Dep.; $1.00(cy), 1(mn) CFSTI
3192	19-13989	Dep.; $1.00(cy), 1(mn) CFSTI
3203-MS	19-13665	Dep.; $1.00(CFSTI)
3208-MS	19-13886	Dep.; $1.00(CFSTI)
LA-DC–		
5981	19-14706	Phys. Fluids, 8: 366-77(1965)
6516(Rev.)	19-14235	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6568	19-14004	Acta Cryst., 18: 294-5(1965)
6607	19-14006	Am. Soc. Metals, Trans. Quart., 58: 30-7 (1965)
6670	19-14526	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6673	19-14527	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6866	19-13666	Dep.(mn); $1.00(cy), 1(mn) CFSTI
LA-tr–		
65-1	19-13284	Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL
LADC–		
6099	19-14026	J. Nucl. Mater., 12: 335-6(1964)
6207	19-13861	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6267	19-13558	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6297	19-13527	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6329	19-13344	J. Mol. Spectry., 15: 68-82(1965)
6330	19-13345	J. Mol. Spectry., 15: 83-99(1965)
LAL–	**(French)**	
1118	19-13724	Dep.(mn)
1120	19-14528	Dep.(mn)
LAMS–		
3002(Suppl.I)	19-14131	Dep.; $3.00(CFSTI)
LF–		
20	19-14910	Dep.; $0.50(CFSTI)
LGI–	**(Italian)**	
63/18	19-14132	Dep.(mn)
LNF–	**(Italian)**	
64/34	19-14174	Dep.(mn)
64/50	19-14434	Dep.(mn)
64/51	19-13725	Dep.(mn)
64/54	19-14175	Dep.(mn)
MATT–		
310	19-14665	Dep.(mn); $1.00(cy), 1(mn) CFSTI
MCW–		
1488	19-13990	Dep.; $2.00(cy), 1(mn) CFSTI
MF–	**(Misc.)**	
42	19-14140	See NYO-1480-8
MIT–	**(Misc.)**	
2098-99	19-14199	Dep.(mn); $2.00(cy), 1(mn) CFSTI
ML-TDR–	**(Non-AEC)**	
64-110	19-13887	$7.85(CFSTI)
64-134	19-13991	$2.00(CFSTI)
64-227	19-13888	$2.00(CFSTI)
64-234	19-13992	$2.00(CFSTI)
MLM–		
1208	19-13889	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1216	19-14911	Dep.; $2.00(cy), 1(mn) CFSTI
1217	19-13201	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1219	19-14730	Dep.; $1.00(cy), 1(mn) CFSTI
1232J	19-13216	Am. Soc. Metals. Trans. Quart., 58: 105-9 (1965)
MMPP-FRPC–		
64-2	19-14529	Dep.(mn); $3.00(cy), 2(mn) CFSTI
MND–	**(Misc.)**	
3149-2	19-14295	$1.00(CFSTI)
N–	**(Misc.)**	
64-31455	19-13954	See WANL-PR(P)-004
65-13446	19-14086	$2.00(CFSTI)
65-14394	19-13955	See WANL-PR-(P)-005
NAA-SR–		
8887	19-13943	Dep.; $0.75(CFSTI)
8955	19-14087	Dep.; $1.50(CFSTI)
8956	19-14088	$0.75(CFSTI)
9781	19-14877	Dep.; $3.00(cy), 1(mn) CFSTI
10153	19-14835	Dep.; $1.00(CFSTI)
10721	19-14836	Dep.; $2.00(cy), 1(mn) CFSTI
NARF–	**(Non-AEC)**	
63-16T	19-13726	$3.00(CFSTI)
NASA-CR–	**(Misc.)**	
148	19-14274	$5.00(CFSTI)
149	19-14275	$4.00(CFSTI)
54166	19-13954	See WANL-PR(P)-004
54232	19-13955	See WANL-PR-(P)-005
NASA-SP–	**(Misc.)**	
5014	19-13890	$1.00(GPO)
NASA-TN–	**(Misc.)**	
D-2612	19-14421	$2.00(CFSTI)
D-2676	19-13608	$1.00(CFSTI)
NEVIS–	**(Misc.)**	
127	19-14312	See CU-233
NLCO–		
940	19-13891	Dep.; $3.00(CFSTI)
NMI–	**(Misc.)**	
2133	19-13947	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2134	19-13893	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6021.13	19-13995	Dep.(mn); $3.00(cy), 2(mn) CFSTI
NOLTR–	**(Misc.)**	
62-207	19-14837	Dep.; $5.00(cy), 4(mn) CFSTI
63-165	19-14666	$6.60(CFSTI)
NP–	**(AEC File No. for Non-AEC Reports)**	
14426	19-13134	Dep.(mn)
14557	19-13580	Dep.(mn)
14560	19-14176	Dep.(mn)
14571	19-14667	Dep.(mn)
14572	19-14668	Dep.(mn)
14593	19-13529	$2.00(cy), 1(mn) CFSTI
14606	19-14530	Dep.(mn)
14625	19-14531	Dep.(mn)
14630	19-13135	Dep.(mn)
14631	19-14321	
14637	19-14322	Dep.(mn)
14661	19-14276	
14664	19-12953	Dep.(mn)
14665	19-12954	Dep.(mn)
14666	19-12955	Dep.(mn)
14667	19-13618	Dep.(mn)
14675	19-13948	
14676	19-14435	

Report No.	Abstract No.	Availability
14677	19-13894	
14688	19-14532	Dep.(mn)
14691	19-13727	Dep.(mn)
14695	19-13728	Dep.(mn)
14696	19-13667	Dep.(mn)
14708	19-13627	Dep.(mn)
14714	19-13729	Dep.(mn)
14718	19-13628	Dep.(mn)
14721	19-13730	Dep.(mn)
14722	19-13731	Dep.(mn)
14752	19-12911	
14761	19-12912	Dep.(mn)
14768	19-13949	
14769	19-14133	
14770	19-13530	Dep.(mn)
14771	19-13915	
14775	19-13732	Dep.(mn)
14777	19-13609	
14778(Pt.III)	19-13629	
14780	19-13668	Dep.(mn)
14783	19-13895	
14784	19-14134	
14785	19-14135	
14786	19-14136	
14787	19-14669	
14788	19-14137	
14789	19-14138	
14790	19-14139	
14796	19-13630	Dep.(mn)
NP-tr-	**(AEC File No. for Non-AEC Translations)**	
1214	19-13285	Dep.(mn); $1.60(fs), $0.80(mf) JCL
NR-	**(Misc.)**	
104-581	19-14916	See ORNL-3634
NRC-	**(Canadian)**	
8174	19-13293	Can. J. Chem., 43: 47-56(1965)
8202	19-13294	Can. J. Chem., 43: 154-8(1965)
NRS-	**(Australian)**	
23	19-13733	Dep.(mn)
24	19-13403	Dep.(mn)
25	19-13734	Dep.(mn)
26	19-14089	Dep.(mn)
NUMEC-		
2389-4	19-13896	Dep.(mn); $3.00(cy), 2(mn) CFSTI
NUS-	**(Misc.)**	
156	19-13669	
NYO-		
162-13	19-13670	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1163-16	19-13648	Dep.(mn); $1.00(cy), 1(mn) CFSTI
NYO-		
98-1	19-13619	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1082-1	19-14533	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1480-8	19-14140	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1938-2	19-14912	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2047-30	19-13424	Dep.(mn); $4.00(cy), 3(mn) CFSTI
2363-2	19-14115	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2383-12	19-13425	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2391-1	19-14436	Dep.(mn); $4.00(cy), 3(mn) CFSTI
2462-1A	19-14913	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2471-7a	19-14914	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2784-5	19-13893	See NMI-2134
2811-21	19-14915	Dep.(mn); $3.00(cy), 2(mn) CFSTI
2910-6	19-13704	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3276-8	19-13203	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3396-3	19-12913	Dep.(mn); $2.00(cy), 1(mn) CFSTI
10295	19-13278	Dep.(mn); $2.00(cy), 1(mn) CFSTI
NYU-AA-	**(Non-AEC)**	
64-2	19-14404	$1.00(cy), 1(mn) CFSTI as AD-607262
ORINS-		
46	19-13404	Dep.; $1.00(CFSTI)

Report No.	Abstract No.	Availability
ORNL-		
3589	19-14090	Dep.; $2.00(CFSTI)
3634	19-14916	Dep.; $3.00(CFSTI)
3722	19-14177	Dep.; $2.00(CFSTI)
3757	19-14793	Dep.; $3.00(cy), 2(mn) CFSTI
ORNL-CPX-		
2	19-14534	Dep.; Free(ORNL)
ORNL-P-	**(Misc.)**	
22	19-13963	J. Nucl. Mater., 13: 283-7(1964)
73	19-13592	Phys. Fluids, 8: 235-41(1965)
408	19-13243	J. Chromatog., 16: 538-40(1964)
464	19-13217	Anal. Chem., 37: 200-3(1965)
813	19-14535	Dep.(mn); $1.00(cy), 1(mn) CFSTI
848	19-14536	Dep.(mn); $1.00(cy), 1(mn) CFSTI
902	19-13531	Dep.(mn); $1.00(cy), 1(mn) CFSTI
925	19-13279	Dep.(mn); $1.00(cy), 1(mn) CFSTI
993	19-13735	Dep.(mn); $2.00(cy), 2(mn) CFSTI
1051	19-13996	Dep.(mn); $1.00(cy), 1(mn) CFSTI
ORNL-TM-		
728	19-14887	Dep.(mn); $8.61(cy), 11(mn) CFSTI
842	19-14466	Dep.(mn); $3.00(cy), 2(mn) CFSTI
990	19-13950	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1008	19-12905	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1020	19-13532	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1052	19-13897	Dep.(mn); $2.00(cy), 1(mn) CFSTI
ORNL-tr-		
402	19-14852	Dep.(mn); $1.60(fs), $0.80(mf) JCL
403	19-14853	Dep.(mn); $1.60(fs), $0.80(mf) JCL
408	19-13958	Dep.(mn); $1.60(fs), $0.80(mf) JCL
461	19-14003	Dep.(mn); $2.60(fs), $1.10(mf) JCL
467	19-14236	Dep.(mn); $3.60(fs), $1.16(mf) JCL
PAN-	**(Polish)**	
540/I	19-14537	Dep.
543/IX	19-14838	Dep.
545/IXA	19-14467	Dep.
547/XVII	19-13426	Dep.
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
976,110	19-13807	
976,137	19-14779	
976,347	19-14780	
976,463	19-14893	
PATENTS	**(German)**	
1,176,371	19-13551	
1,181,684	19-13552	
PATENTS	**(U. S.)**	
3,158,544	19-14781	
3,158,545	19-14782	
3,158,546	19-14783	
3,158,743	19-13658	
3,158,764	19-14303	
3,158,792	19-14458	
3,158,793	19-14459	
3,161,569	19-14784	
3,161,572	19-14863	
3,161,599	19-13520	
3,161,774	19-13808	
3,161,776	19-13604	
3,161,786	19-14809	
3,161,788	19-14304	
3,161,789	19-14305	
3,161,809	19-14460	
3,163,759	19-13809	
3,165,376	19-13553	
3,169,057	19-13554	
3,169,187	19-13810	
3,169,200	19-14306	
PUC-		
1964-140	19-14496	See ANL-6878(p.335-50)
R-	**(Misc.)**	
326	19-13605	See AD-605502

Report No.	Abstract No.	Availability
468	19-14312	See CU-233
5776-3	19-13948	See NP-14675
RADC-TDR–	**(Misc.)**	
64-207	19-13705	$2.00(CFSTI)
RFP–		
490	19-13898	Dep.; $0.50(CFSTI)
RISLEY-Trans–	**(British)**	
280	19-13559	Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL
RISÖ–	**(Danish)**	
72	19-14473	Acta Cryst., 18: 184-8(1965)
RL-SA–		
17A	19-14866	Dep.(mn); $1.00(cy), 1(mn) CFSTI
RLE-TR–	**(Non-AEC)**	
424	19-14141	
RM–	**(Misc.)**	
65TMP-4	19-14422	
RMI–	**(Non-AEC)**	
1	19-13951	Dep.; $1.00(cy), 1(mn) CFSTI
RPI–	**(Misc.)**	
328-18	19-14468	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2714-4	19-13533	Dep.(mn); $2.00(cy), 1(mn) CFSTI
RSIC–	**(Non-AEC)**	
202	19-13997	
RTD-TDR–	**(Non-AEC)**	
63-3003	19-14878	$19.75(CFSTI)
RTD-TR–	**(Non-AEC)**	
8-112(Vol.IV)	19-13952	$4.00(CFSTI)
SAN–		
366-1	19-13843	Dep.(mn); $6.00(cy), 5(mn) CFSTI
413-2	19-14894	Dep.; $2.00(cy), 1(mn) CFSTI
8002	19-14775	Dep.; $7.00(CFSTI)
SC-DC–		
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